SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section provides safety considerations, logic symbols, troubleshooting procedures, block diagram and description, circuit theory, component location photos, and schematic diagram (service information).

8-3. SAFETY CONSIDERATIONS

8-4. Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition (see Sections II, III, and V). Service and adjustments should be performed only by qualified service personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

8-5. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

8-6. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

8-7. Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

8-8. Whenever it is likely that this protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

WARNING

THE SERVICE INFORMATION IS OFTEN USED WITH LINE POWER SUPPLIED AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

8-9. RECOMMENDED TEST EQUIPMENT

8-10. Test equipment and test equipment accessories required to maintain the 5004A are listed in *Table 1-2*. Equipment other than that listed may be used if it meets the listed critical specifications.

8-11. LOGIC SYMBOLS

8-12. Logic symbols used in this manual conform to the American National Standard ANSI Y32.14-1973 (IEE Std. 91-1973). This standard supersedes MIL-STD-806B. In the following paragraphs logic symbols are described.

8-13. Logic Concepts

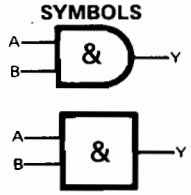
8-14. The binary numbers 1 and Ø are used in pure logic where 1 represents true, yes, or active and Ø represents false, no, or inactive. These terms should not be confused with the physical quantity (e.g., voltage) that may be used to implement the logic, nor should the term "active" be confused with a level that turns a device on or off. A truth table for a relationship in logic shows (implicitly or explicity) all the combinations of true and false input conditions and the result (output). There are only two basic logic relationship, AND and OR. The following illustrations assume two inputs (A and B), but these can be generalized to apply to more than two inputs.

AND Y is true if and only if A is true and B is true (or more generally, if all inputs are true).
Y=1 if and only if A=1 *and* B=1.
Y=A•B

TRUTH TABLE

A	B	Y
1	1	1
1	0	0
0	1	0
0	0	0

EQUIVALENT SYMBOLS

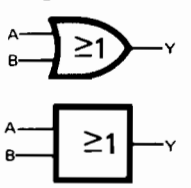


OR Y is true if and only if A is true or B is true (or more generally, if one or more input(s) is (are) true).
Y=1 if and only if A=1 *or* B=1.
Y=A+B

TRUTH TABLE

A	B	Y
1	1	1
1	0	1
0	1	1
0	0	0

EQUIVALENT SYMBOLS



8-15. Negation

8-16. In logic symbology, the presence of the negation indication symbol ○ provides for the representation of logic function inputs and outputs in terms *independent* of their physical values; the 0-state of the input or output being the 1-state of the symbol referred to by the symbol description.

EXAMPLE 1

TRUTH TABLE

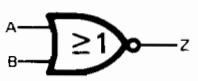
A	B	Z
1	1	0
1	0	1
0	1	1
0	0	1

EXAMPLE 2

TRUTH TABLE

A	B	Z
1	1	0
1	0	1
0	1	1
0	0	1

EXAMPLE 3



TRUTH TABLE

A	B	Z
1	1	0
1	0	0
0	1	0
0	0	1

EXAMPLE 4

TRUTH TABLE

A	B	Z
1	1	0
1	0	0
0	1	0
0	0	1

EXAMPLE 1 says that Z is *not* true if A is true *and* B is true or that Z is true if A *and* B are *not* both true. Z=AB or Z=AB. This is frequently referred to as NAND (for NOT AND).

EXAMPLE 2 says that Z is true if A is *not* true *or* if B is *not* true. Z = A + B. Note that this truth table is identical to that of Example 1. The logic equation is merely a De Morgan's transformation of the equations in Example 1. The symbols are equivalent.

EXAMPLE 3 Z = A + B or Z = A + B and,

EXAMPLE 4 Z = A • B, also share common truth table and are equivalent transformations of each other. The NOT OR form (Example 3) is frequently referred to as NOR.

NOTE

In this manual the logic negation symbol is NOT used.

8-17. Logic Implementation and Polarity Indication

8-18. Devices that can perform the basic logic functions, AND and OR, are called gates. Any device that can perform one of these functions can also be used to perform the other if the relationship of the input and output voltage levels to the logic variables 1 and Ø is redefined suitably.

8-19. In describing the operation of electronic logic devices, the symbol H is used to represent a "high level," which is a voltage within the more-positive (less-negative) of the two ranges of voltages used to represent the binary variables. L is used to represent a "low level," which is a voltage within the less-positive (more-negative) range.

8-20. A function table for a device shows (implicity or explicitly) all the combinations of input conditions and the resulting output conditions.

8-21. In graphic cymbols, inputs or outputs that are active when at the high level are shown without polarity indication. The polarity indicator symbol ◺ denotes that the active (one) state of an input or output *with respect to the symbol to which it is attached* is the low level.

NOTE

The polarity indicator symbol "◺" is used in this manual.

EXAMPLE 5
Assume two devices having the following function tables.

DEVICE #1
FUNCTION TABLE

A	B	Y
H	H	H
H	L	L
L	H	L
L	L	L

DEVICE #2
FUNCTION TABLE

A	B	Y
H	H	H
H	L	H
L	H	H
L	L	L

POSITIVE LOGIC
By assigning the relationships H=1, L=0 at both input and output, Device #1 can perform the AND function and Device #2 can perform the OR function. Such a consistent assignment is referred to as positive logic. The corresponding logic symbols would be:

NEGATIVE LOGIC

Alternatively, by assigning the relationship H=0, L=1 at both input and output, Device #1 can perform the OR function and Device #2 can perform the AND function. Such a consistent assignment is referred to as negative logic. The corresponding logic symbols would be:

8-22. MIXED LOGIC. The use of the polarity indicator symbol (▷) automatically invokes a mixed-logic convention. This is, positive logic is used at the input and outputs that do not have polarity indicators, negative logic is used at the inputs and outputs that have polarity indicators.

EXAMPLE 6
FUNCTION TABLE

A	B	Z
H	H	L
H	L	H
L	H	H
L	L	H

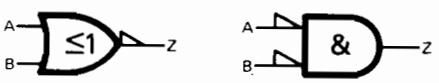
This may be shown either of two ways:

Note the equivalence of these symbols to examples 1 and 2 and the fact that the function table is a positive-logic translation (H=1, L=0 of the NAND truth table, and also note that the function table is the negative-logic translation (H=0, L=1) of the NOR truth table, given in Example 3.

EXAMPLE 7
FUNCTION TABLE

A	B	Z
H	H	L
H	L	L
L	H	L
L	L	H

This may be shown either of two ways:



Note the equivalence of these symbols to examples 3 and 4 and the fact that the funcion table is a positive-logic translation (H=1, L=0) of the NOR truth table, and also note that the function table is the negative-logic translation (H=0, L=1) of the NAND truth table, given in Example 1.

8-23. It should be noted that one can easily convert from the symbology of positive-logic merely by substituting a polarity indicator (▷) for each negative indicator (○) while leaving the distinctive shapes alone. To convert from the symbology of negative logic, a polarity indicator (▷) is substituted for each negation indicator (○) and the OR shape is substituted for the AND shape or vice versa.

8-24. It was shown that any device that can perform OR logic can also perform AND lgoic and vice versa. De Morgan's transformation is illustrated in Examples 1 through 7. The rules of the transformation are:

1. At each input or output having a negation (○) or polarity (▷) indicator, delete the indicator.
2. At each input or output not having an indicator, add a negation (○) or polarity (▷) indicator.
3. Substitute the AND symbol (⊐) for the OR symbol (⊃) or vice versa.

   These steps do not alter the assumed convention; positive-logic stays positive, negative-logic stays negative, and mixed-logic stays mixed.

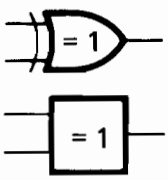
8-25. The choice of symbol may be influenced by these considerations: (1) The operation being performed may best be understood as AND or OR. (2) In a function more complex than a basic gate, the inputs will usually be considered as inherently active high or active low (e.g., the J and K inputs of a J-K flip-flop are active high and active low, respectively). (3) In a chain of logic, understanding and the writing of logic equations are often facilitated if active-low or negated outputs feed into active-low or negated inputs.

8-26. Other Symbols

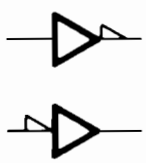
8-27. More symbols are required to depict complex logic diagrams. Some of the other symbols are as follows:

Dynamic input activated by transition from a low level to a high level. The opposite transition has no effect at the output.

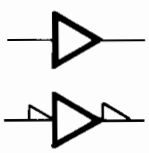
Dynamic input activated by transition from a high level to a low level. The opposite transition has no effect at the output.



Exclusive OR function. The output will assume its indicated active level if and only if one and only one of the two inputs assumes its indicated active level.

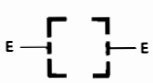


Inverting function. The output is low if the input is high and it is high if the input is low. The two symbols shown are equivalent.

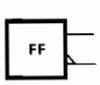


Noninverting function. The output is high if the input is high and it is low if the input is low. The two symbols shown are equivalent.

OUTPUT DELAY. The output signal is effective when the input signal returns to its opposite state.

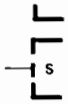


EXTENDER. Indicates when a logic function increases (extends) the number of inputs to another logic function.



FLIP-FLOP. A binary sequential element with two stable states: a set (1) state and a reset (0) state. Outputs are shown in the 1 state when the flip-flop is set. In the reset state the outputs will be opposite to the set state.

RESET. A 1 input will reset the flip-flop. A return to 0 will cause no further effect.



SET. A 1 input will set the flip-flop. A return to 0 will cause no further action.

TOGGLE. A 1 input will cause the flip-flop to change state. A return to 0 will cause no further action.

J INPUT. Similar to the S input except if both J and K (see below) are at 1, the flip-flop changes state.

K INPUT. Similar to the R input (see above).

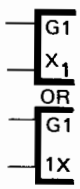
D INPUT (Data). Always dependent on another input (usually C). When the C and D inputs are at 1, the flip-flop will be set. When the C is 1 and the D is 0, the flip-flop will reset.

Address symbol has multiplexing relationship at inputs and demultiplexing relationship at outputs.

8-28. Dependency Notation "C" "G" "V" "F"

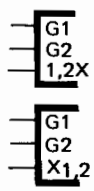
8-29. Dependency Notation is a way to simplify symbols for complex IC elements by defining the existence of an AND relationship between inputs, or by the AND conditioning of an output by an input without actually showing all the elements and interconnections involved. The following examples use the letter "C" for control and "G" for gate. The dependent input is labeled with a number that is either prefixed (e.g., 1X) or subscripted (e.g., X_1). They both mean the same thing. The letter V is used to indicate an OR relationship between inputs or between inputs and outputs with this letter (V). The letter F indicates a connect-disconnect relationship. If the F (free dependency) inputs or outputs are active (1) the other usual normal conditions apply. If one or more of the F inputs are inactive (0), the related F output is disconnected from its normal output condition (it floats).

The input that controls or gates other inputs is labeled with a "C" or a "G", followed by an identifying number. The controlled or gated input or output is labeled with the same number. In this example, "1" is controlled by "G1."



When the controlled or gated input or output already has a functional lable (X is used here), that label will be prefixed or subscripted by the identifying number.

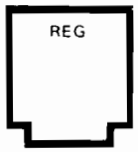
If a particular device has only one gating or control input then the identifying number may be eliminated and the relationship shown with a subscript.



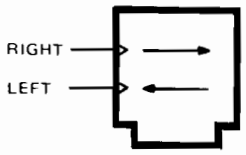
If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear in the prefix or subscript, separated by commas. In this example "X" is controlled by "G1" and "G2."

8-30. Control Blocks

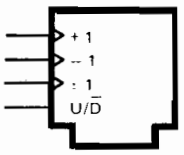
8-31. A class of symbols for complex logic are called control blocks. Control blocks are used to show where common control signals are applied to a group of functionally separate units. Examples of types of control blocks follow.



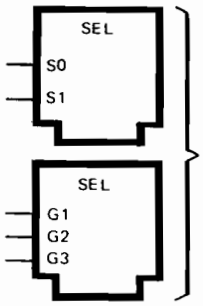
Register control block. This symbol is used with an associated array of flip-flop symbols to provide a point of placement for common function lines, such as a common clear.



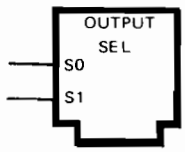
Shift register control block. These symbols are used with any array of flip-flop symbols to form a shift register. An active transition at the inputs causes left or right shifting as indicated.



Counter control block. The symbol is used with an array of flip-flops or other circuits serving as a binary or decade counter. An active transition at the +1 or −1 input causes the counter to increment one count upward or downward, respectively. An active transition at the ±1 input causes the counter to increment one count upward or downward depending on the input at an up/down control.



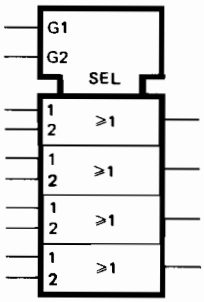
Selector control block. These symbols are used with an array of OR symbols to provide a point of placement for selection (S) or gating (G) lines. The selection lines enable the input designated 0, 1, ...n of each OR function by means of a binary code where S0 is the least-significant digit. If the 1 level of these lines is low, polarity indicators (◺) will be used. The gating lines have an AND relation with the respective input of each OR function: G1 with the inputs numbered 1, G2 with the input numbered 2, and so forth. If the enabling levels of these lines is low, polarity indicators (◺) will be used.



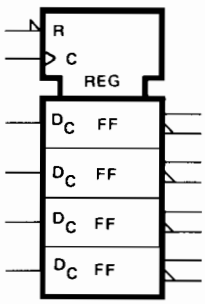
Output selector control block. This symbol is used with a block symbol having multiple outputs to form a decoder. The selection lines enable the output designated 0, 1, ...n of each block by means of a binary code where S0 is the least-significant digit. If the 1 level of these lines is low, polarity indicators (◺) will be used.

8-32. Complex Logic Devices

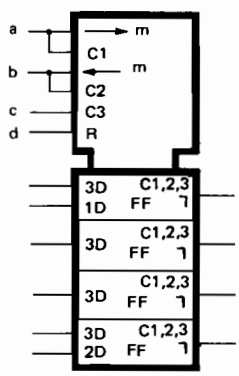
8-33. Logic elements can be combined to produce very complex devices that can perform more difficult functions. A control block symbol can be used bo simplify understanding of many complex devices. Several examples of complex devices are given here.



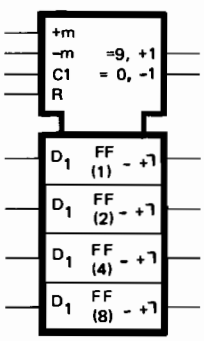
Selector Control Block used to simplify AND portion of a quad AND-OR select gate. When G1 is high, the data presented at the "1" inputs will be gated through. When G2 is high, the data presented at the "2" inputs will be gated through.



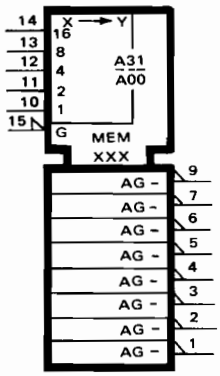
Register control block used to illustrate a quad D-type latch. There is a common active-low reset (R), and a common edge-triggered control input (C). Since there is only one dependency relationship, the controlling input is not numbered and the controlled functions (D) are subscripted with a C.



Shift Register Control Block used to show common inputs to a bidirectional shift register. Notice that "→m" means shift the contents to the right or down by "m" units. And "←m" means shift the contents to the left or up by "m" units. Note: If m=1, it may be omitted. Inputs "a" and "b" are each single IC pins that have two functions. Input "a" enables one of the inputs to the top D-type flip-flop (1D), and also shifts the register contents down one unit. Input "b" enables one of the inputs to the bottom flip-flop (2D), and also shifts the register contents up one unit. Input "c" loads all four flip-flops in parallel (3D). Input "d" is a common reset. The output delay indicator is used because these are master-slave flip-flops.



Counter Control Block used to show common inputs to a Presettable Decade Up/Down Counter. Notice that "+m" means count up (increment the count) by "m;" "-m" means count down by "m." Note: if m=1, it may be omitted. Since the D-type flip-flops are master-slave, the output delay indicator is used. The "=9, +1" and "=9, -1" notation defines when the carry and borrow outputs are generated. They also define it, as a decade counter; a binary counter would have carry indicated with "=15, +1." Flip-flop weighting is indicated in parenthesis.



Read Only Memory (ROM) with 32 addresses. Address selection is determined by the five upper inputs which are decoded into 32 possible addresses (A00 through A31) corresponding to the weighting modifiers at the inputs. Input modifier G (pin 15) gates the outputs. Stored data will be read from the selected memory address if G is active (low). The output data pins (1—7 and 9) are active low. The "—" indicator shows the 8 outputs are capable of supplying low outputs only. A high output is usually supplied by a resistor to a "high" voltage.

8-34. TROUBLESHOOTING (FAILURE ANALYSIS)

8-35. Information to help locate a fault or trouble in the 5004A is given in the following material.

8-36. Several troubleshooting aids are permanently built-in the 5004A. The SELF-TEST front panel switch is one. The main assembly (motherboard) NORMAL SERVICE switch is another. The front panel GATE lamp is another. The four-front panel seven-segment digit displays are another. The front panel UNSTABLE SIGNATURE is another.

8-37. The front panel SELF-TEST switch operation is described in Section III of this manual.

8-38. Troubleshooting Flowchart

8-39. *Figure 8-1*, the troubleshooting flowchart may be used to locate a faulty component. A suggested sequence for troubleshooting is:

a. Perform the Operator's Self-Test (see in Section III).
b. If the 5004A does not pass the Operators Self-test, perform the steps given in the troubleshooting flowchart (*Figure 8-1*).

8-40. Major Test Point Signatures

8-41. *Table 8-1* lists the signatures for the major test points.

8-42.Troubleshooting Signatures with SELF-TEST and NORMAL/SERVICE Switches

8-43. *Table 8-2* is a listing of signatures taken from a correctly operating 5004A with a second correctly operating 5004A. These signatures may be used to locate the cause of a malfunction in a 5004A Signature Analyzer. To take most of the signatures listed requires that the top cover of the 5004A be removed. Refer to the disassembly procedures before attempting to remove the top cover.

WARNING

IF THE 5004A TOP COVER IS REMOVED, DANGEROUS VOLTAGES ARE EXPOSED. ONLY QUALIFIED ELECTRONIC SERVICE TECHNICIANS SHOULD ATTEMPT TO SERVICE THE 5004A WITH COVERS REMOVED.

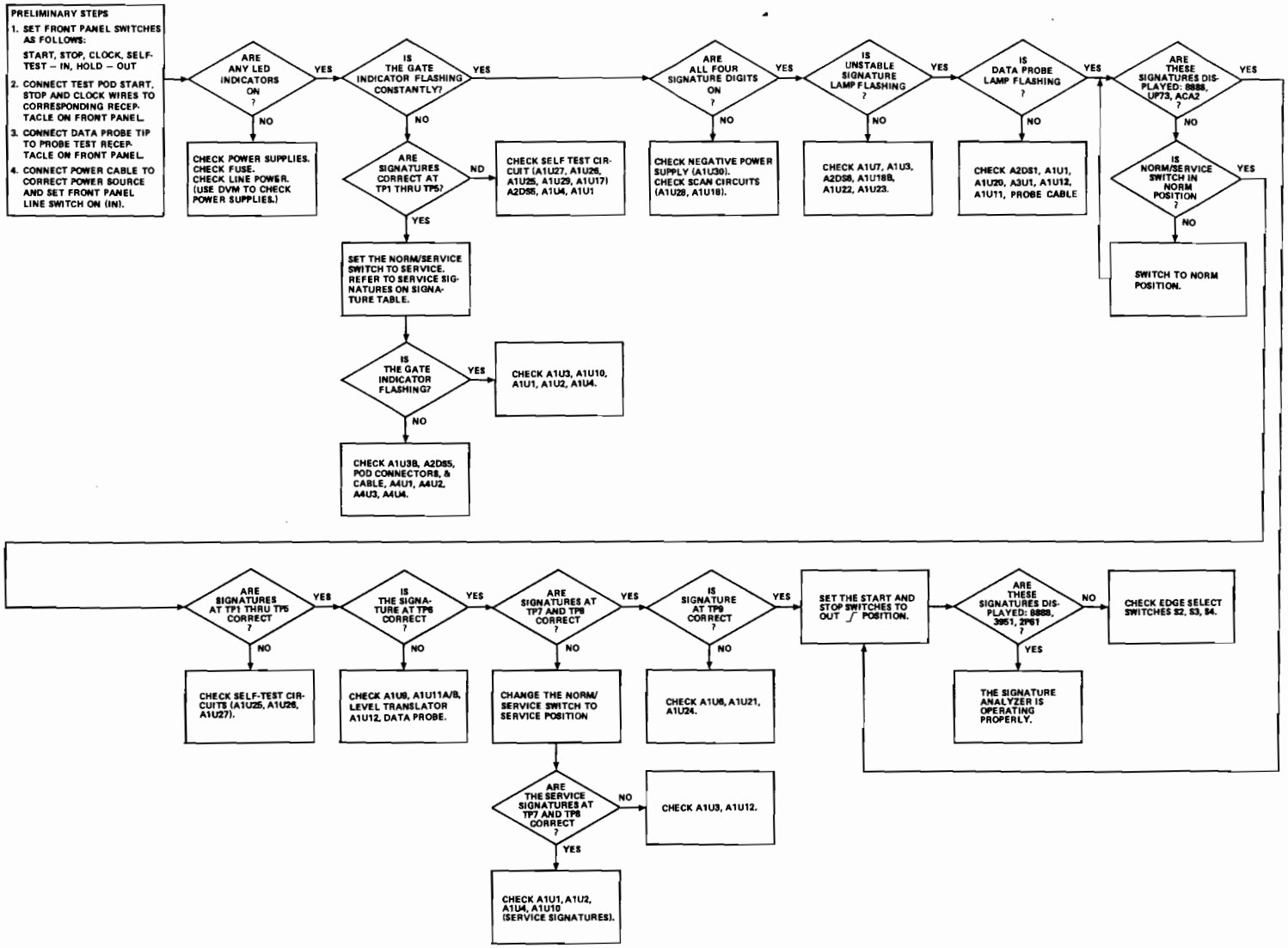

PRELIMINARY STEPS
1. SET FRONT PANEL SWITCHES AS FOLLOWS:
START, STOP, CLOCK, SELF-TEST – IN, HOLD – OUT
2. CONNECT TEST POD START, STOP AND CLOCK WIRES TO CORRESPONDING RECEPTACLE ON FRONT PANEL.
3. CONNECT DATA PROBE TIP TO PROBE TEST RECEPTACLE ON FRONT PANEL.
4. CONNECT POWER CABLE TO CORRECT POWER SOURCE AND SET FRONT PANEL LINE SWITCH ON (IN).
ARE ANY LED INDICATORS ON ?
YES
NO
CHECK POWER SUPPLIES. CHECK FUSE. CHECK LINE POWER. (USE DVM TO CHECK POWER SUPPLIES.)
IS THE GATE INDICATOR FLASHING CONSTANTLY?
YES
NO
ARE SIGNATURES CORRECT AT TP1 THRU TP5?
NO
YES
CHECK SELF TEST CIRCUIT (A1U27, A1U26, A1U25, A1U29, A1U17) A2DS8, A1U4, A1U1
SET THE NORM/SERVICE SWITCH TO SERVICE. REFER TO SERVICE SIGNATURES ON SIGNATURE TABLE.
IS THE GATE INDICATOR FLASHING?
YES
NO
CHECK A1U3, A1U10, A1U1, A1U2, A1U4.
CHECK A1U3B, A2DS5, POD CONNECTORS, & CABLE, A4U1, A4U2, A4U3, A4U4.
ARE ALL FOUR SIGNATURE DIGITS ON ?
YES
NO
CHECK NEGATIVE POWER SUPPLY (A1U30). CHECK SCAN CIRCUITS (A1U29, A1U18).
IS UNSTABLE SIGNATURE LAMP FLASHING ?
YES
NO
CHECK A1U7, A1U3, A2DS8, A1U18B, A1U22, A1U23.
IS DATA PROBE LAMP FLASHING ?
YES
NO
CHECK A2DS1, A1U1, A1U20, A3U1, A1U12, A1U11, PROBE CABLE
ARE THESE SIGNATURES DISPLAYED: 8888, UP73, ACA2 ?
YES
NO
IS NORM/SERVICE SWITCH IN NORM POSITION ?
YES
NO
SWITCH TO NORM POSITION.
ARE SIGNATURES AT TP1 THRU TP5 CORRECT ?
YES
NO
CHECK SELF-TEST CIRCUITS (A1U25, A1U26, A1U27).
IS THE SIGNATURE AT TP6 CORRECT ?
YES
NO
CHECK A1U9, A1U11A/B, LEVEL TRANSLATOR A1U12, DATA PROBE.
ARE SIGNATURES AT TP7 AND TP8 CORRECT ?
YES
NO
CHANGE THE NORM/SERVICE SWITCH TO SERVICE POSITION
ARE THE SERVICE SIGNATURES AT TP7 AND TP8 CORRECT ?
NO
YES
CHECK A1U3, A1U12.
CHECK A1U1, A1U2, A1U4, A1U10 (SERVICE SIGNATURES).
IS SIGNATURE AT TP9 CORRECT ?
YES
NO
CHECK A1U6, A1U21, A1U24.
SET THE START AND STOP SWITCHES TO OUT ⎍ POSITION.
ARE THESE SIGNATURES DISPLAYED: 8888, 3951, 2P61 ?
NO
YES
CHECK EDGE SELECT SWITCHES S2, S3, S4.
THE SIGNATURE ANALYZER IS OPERATING PROPERLY.

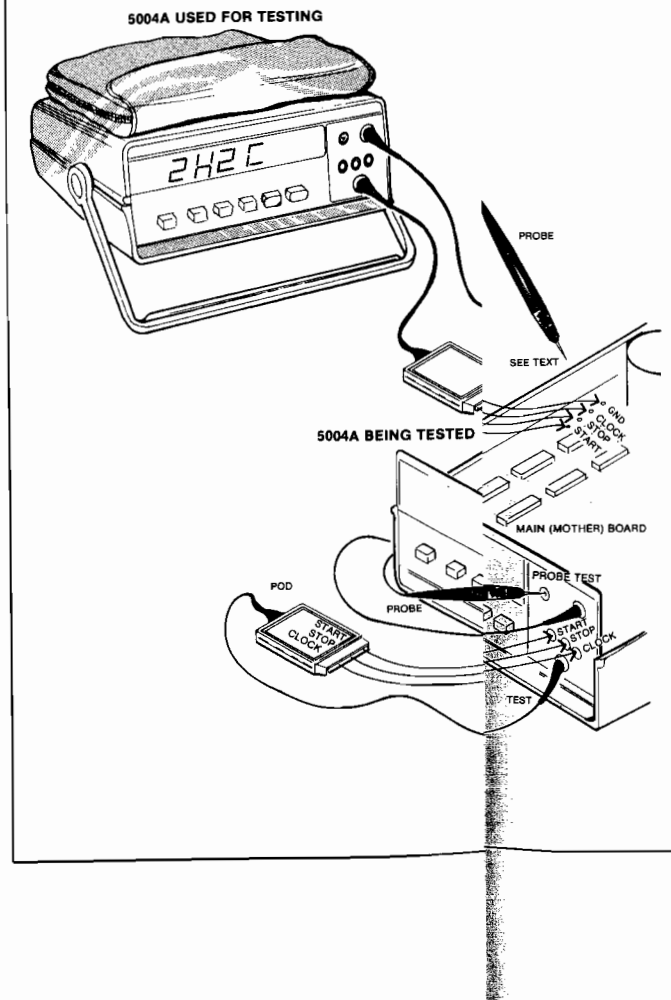
Table 8-1. Troubleshooting Signatures Major Test Points

Test Point*	Location	Signature	
		NORMAL	SERVICE
①	U25(11)	FLIFLI	←
②	U29(1)	54PH	←
③	U29(2)	0166	←
④	U29(3)	HH4b	←
⑤	U29(4)	HALI 1	←
⑥	U9(5)	596F	←
⑦	U11(8)	U36U	bPGF
⑧	U7(4), U24(9)	4C4F	125P
⑨	U24(13), U6(10)	F94H	CFU5

*Test point numbers are shown on the schematic diagram for the 5004A.

Figure 8-1. Troubleshooting Flowchart

Table 8-2. SELF-TEST and NORMAL/SERVICE Signatures



PINS	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	PIN
1 N	472A	5A22		1H08	5A22	472A	F517	UCP9	472A	7CA7	1
S	472A	94A3		H389	94A3	472A	P7AA	PF43	472A	7CA7	
2 N	A326	A326		09P3	472A	472A	0000	P36F	3F8H	7CA7	2
S	A326	A326		09P3	472A	472A	0000	P36F	3F8H	7CA7	
3 N	P40F	UCP9		1H08		472A	823H	CFF3	7CA7	472A	3
S	P40F	PF43		H389		472A	A080	Ac69	7CA7	472A	
4 N	464F	UCP9		UCP9	P40F	472A	4C4F	CFF3	472A	0000	4
S	464F	PF43		PF43	P40F	472A	12SP	AC69	472A	0000	
5 N	13F7	UCP9		UCP9	5829	596F	0F66	66P0	596F	472A	5
S	13F7	PF43		PF43	A427	596F	5574	6606	596F	472A	
6 N	4PF9	3P06		UCP9	H4U0	0147	0000	UCP9	1P46	0000	6
S	4PF9	62CF		PF43	6H73	42U6	0000	PF43	1P46	0000	
7 N	09P3	0000		0000	0000	0000	0000	0000		0000	7
S	09P3	0000		0000	0000	0000	0000	0000		0000	
8 N	0000	0000		C445	66P0	0000	H4U0	472A	0000	13F7	8
S	0000	0000		1669	6606	0000	6H73	472A	0000	13F7	
9 N	0000	5829		5829	5829	0000	HAU1	FUFU		54PH	9
S	0000	A427		A427	A427		HAU1	FUFU		54PH	
10 N		4PF9		P40F	P40F	F944	0F66	0863		464F	10
S		4PF9		P405	P40F	CFU5	5574	0863		464F	
11 N	5829	4PF9		5829	P40F	AUF8	4596	7CA7		0166	11
S	A427	4PF9		A427		HHH5	4596	7CA7		0166	
12 N	3P06	4PF9	54PH	1H08	5A22	2CAU	2946	7A33		0166	12
S	F61C	4PF9	54PH	H389	94A3	6PAH	2946	7A33		0166	
13 N	C445	A326	0166	1H08	P36F	1501	90FP	4596		A446	13
S	2946	A326	0166	H389	P36F	1417	90FP	4596		A446	
14 N	1H08	472A		472A	472A	472A	472A	472A		472A	14
S	H389	472A		472A	472A	472A	472A	472A		472A	
15 N	5A22								472A		15
S	94A3								472A		
16 N	472A								472A		16
S	472A								472A		

N = NORMAL
S = SERVICE position of S7.

To get the signatures given in this table, set the two 5004A's controls as follows:

5004A Being Tested
LINE:OFF; START:OUT; STOP:OUT; HOLD:OUT; SELF-TEST:IN.

5004A Used to Test
Same as above except SELF-TEST:OUT

Make the connections shown between the two 5004A's.

PIN	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	PIN
1 N	7CAF						90FP	0000	6892		1
S	7CAF						90FP	0000	802C		
2 N	7CAF						HH53		443F		2
S	7CAF						HH53		80CH		
3 N	3F8H		75U6	75U6	75U6	75U6	75U6		2CHF		3
S	3F8H		0261	0261	0261	0261	0261		99U2		
4 N	3F8H	0000	A096	A096	A096	A096		4C78	27U3		4
S	3F8H	0000	92PC	92PC	92PC	92PC		4C78	9H02		
5 N	3F8H	472A	3A0U	3A0U	3A0U	3A0U	0863	25CF	069C		5
S	3F8H	472A	9664	9664	9664	9664		25CF	0HAH		
6 N	7CA7		FU22	FU22	FU22	FU22	A096	7661	78CP		6
S	7CA7		C152	C152	C152	C152	92PC	7661	PH0C		
7 N	0000						0000	5U8U	P73H		7
S	0000						0000	5U8U	CH2U		
8 N	U36U		0000	0000	0000	0000	FU22	0000			8
S	6P6F		0000	0000	0000	0000	C152	0000			
9 N	C445		0000	0000	0000	0000	7A33	472A		9	
S	2946		0000	0000	0000	0000	7A33	472A			
10 N	C445		0000	0000	0000	0000					10
S	2946		0000	0000	0000	0000					
11 N	472A		FH33	C826	F94H	AUF8	3A0U	0000			11
S	472A		FUAU	PU7H	CFU5	HHH5	9664	0000			
12 N	3F8H	3F8H	1501	6C7H	929A	475F	29PP	472A			12
S	3F8H	3F8H	1417	5553	U242	3003	29PP	472A			
13 N	7CAF	7CA7	APH9	5F97	2535	9FU2		472A			13
S	7CAF	7CA7	3AAA	C822	U600	7282		472A			
14 N	472A		54F8	94FH	52A7	2CAU	472A	0000	0000		14
S	472A		UPUF	7CCH	67A8	6PAH	472A	0000	0000		
15 N			0000	0000	0000	0000		0000	0000		15
S			0000	0000	0000	0000		0000	0000		
16 N								472A	472A		16
S								472A	472A		

PIN	U21	U22	U23	U24	U25	U26	U27	U28	U29	U30	PIN
1 N	0147				F61C	0000	HH53		54PH		1
S	596F				F61C	0000	HH53		54PH		
2 N	0147				0000	0000	0000		0166		2
S	596F				0000	0000	0000		0166		
3 N	94FH			2CAU	0000	0000	0000		A446		3
S	7CCH			6PAH	0000	0000	0000		A446		
4 N	SF97	29PP		9FU2	2946				HAU1		4
S	C822	29PP		7282	2946				HAU1		
5 N	6C7H	7A33		47F5							5
S	5553	7A33		3003							
6 N	CB26	14HA		AUF8							6
S	PU7H	7782		HHH5							
7 N	0000	29H7		0000							7
S	0000	P5U1		0000							
8 N					4596	29PP	3A9A				8
S					4596	29PP	3A9A				
9 N		207P				7A33	H10F				9
S		A5C9			2946	7A33	H10F				
10 N	54F8	F2P7	F2P7	52A7					29PP		10
S	UPUF	OFC1	OFC1	67A8					29PP		
11 N	APH9	0000		2535	FUFU	0863	0108		0863		11
S	3AAA	0000		U600	FUFU	0863	0108		0863		
12 N	1501	472A	207P	929A	F61C	0000	HH53				12
S	1417	472A	A5C9	U242	F61C	0000					
13 N	FH33	29PP	29H7	F94H							13
S	FUHU	29PP	P5U1	CFU5							
14 N	472A			472A	0108	0000	0863				14
S	472A			472A	0108	0000	0863				
15 N			14HA								15
S			7782								
16 N											16
S											

8-44. DISASSEMBLY AND REASSEMBLY PROCEDURES

8-45. To remove the 5004A covers, use the following procedure:

WARNING

WHEN THE COVERS ARE REMOVED FROM THE 5004A, LINE VOLTAGES WHICH ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY WHEN TOUCHED. DO NOT REMOVE THE COVERS UNLESS IT IS NECESSARY.

1. Disconnect the power cable from the rear panel of the 5004A.
2. Turn the 5004A over with the cable case down. Four screws are exposed.
3. On the back panel of the 5004A loosen the two screws at the ends of the heat sink three or four turns (see *Figure 8-2*).

NOTE

DO NOT loosen the transistor retaining screws (see *Figure 8-2*).

4. Remove the four screws near the four corners of the cabinet bottom.
5. Hold the top and bottom covers together and turn the 5004A right side up.
6. Carefully lift the top cover off.

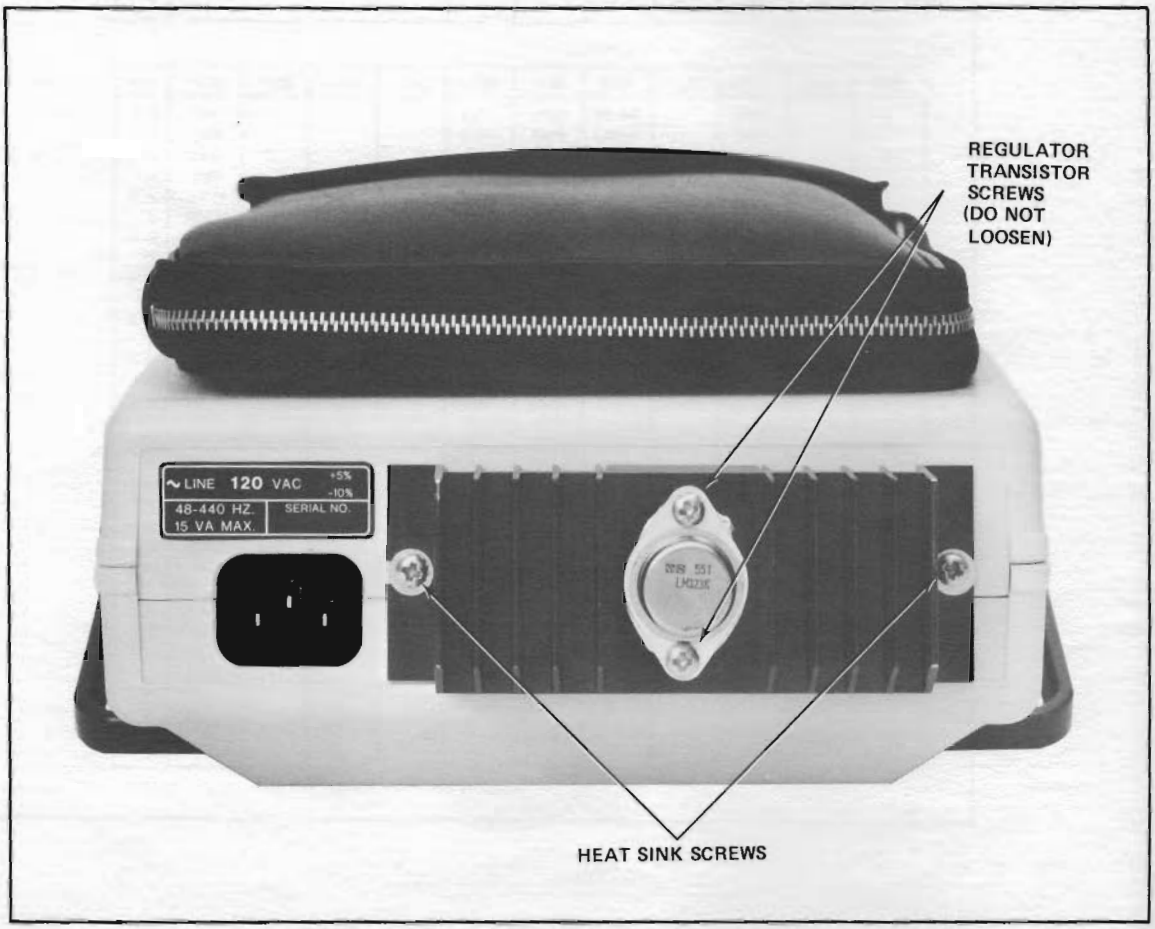


Figure 8-2. Heat Sink Screws Locations

NOTE

If the heat sink on the rear panel is still holding the cover together, loosen the sink screws a few more turns.

WARNING

BE CAREFUL OF EXPOSED LINE VOLTAGE POINTS.

7. If necessary the bottom cover can be removed.
8. To reassemble the 5004A reverse the preceding steps.

8–46. Data Probe Disassembly and Reassembly

8–47. To disassemble the data probe, use the following procedure.

1. Disconnect the power cable from the 5004A. Remove the GND wire from the probe.

NOTE

Figure 6–1 shows the mechanical parts of the probe. *Figure 8–7* shows the probe with its covers removed.

2. Remove the probe tip by turning it with fingers counterclockwise.

NOTE

The red window has a projecting stud that fits in the body of the probe near the GND pin (off-set slightly).

3. Carefully pull the red window off the probe tip.
4, Slide the two half covers carefully off the probe printed circuit board.

NOTE

The two body shells interlock to cover the printed circuit board.

5. Reverse the preceding steps to reassemble the data probe.

8–48. Gating Signals Pod Disassembly and Reassembly

8–49. To disassemble the gating signals pod, use the following procedure.

1. Disconnect the power cable from the 5004A.

NOTE

Figure 6–1 shows the mechanical parts of the pod. *Figure 8–7* shows the probe with its covers removed.

2. Squeeze the ends of the pod test leads connector and pull the connector off the pod.
3. Remove the four screws from the bottom cover of the pod, and carefully remove the top cover. The bottom cover can also be removed if necessary.

NOTE

The pod cable has a strain protector which fits in a slot in the covers of the pod.

4. Reverse the above procedure to reassemble the pod.

8-50. BLOCK DIAGRAM DESCRIPTION

8-51. In the following paragraphs a description of the 5004A Signature Analyzer is given to match *Figure 8-3* the block diagram in this section. A more detailed description of the 5004A is given in the paragraphs following the heading: CIRCUIT THEORY (PRINCIPLES OF OPERATION) (SCHEMATIC DIAGRAM DESCRIPTION).

8-52. A 5004A Signature Analyzer requires four input signals: START, STOP, CLOCK, and DATA. START, CLOCK, and STOP inputs are applied to the 5004A through the GATING SIGNALS POD.

8-53. Data Signal Path. DATA input is through the DATA PROBE. Signals applied to the DATA PROBE are connected to dual paths which trigger at high and low voltage levels respectively. The output of these level detectors is at ECL level and drive a pair of ECL to TTL converters on the main assembly. A logic level detector across the ECL converters provides the drive for the logic level indicator at the data probe tip. The outputs of the ECL converters is translated from a possible three levels (high, bad (middle), and low) to standard high or low levels at the selected clock. (When a bad level appears at the input of the data probe, it is converted to whatever the previous data level was: (either high or low.) Data from the 3-to-2 level converter is applied to the pseudo-random word generator with corresponding gate and clock signals. For each different clocked data stream (series of bits) bracketed by a start and stop signal, a different word (signature) is generated by the word generator. Each signature is sent to the display latches which supply them to the decoder-driver and the signature comparator. The decoder-driver translates the signature to a special-form hexadecimal number which is applied to the display. Each succeeding signature is compared with the preceding signature in the signature comparator which will activate the UNSTABLE SIGNATURE lamp if two succeeding signatures are different. The RESET function for the entire 5004A is part of the DATA probe. RESET is activated by a switch (labeled RESET) on the DATA probe.

8-54. Clock, Start, and Stop Signal Paths

8-55. External CLOCK, START, and STOP signals are applied to the 5004A through the gating signals pod. Input CLOCK, START, and STOP signals are eamplified, and connected to operator-controlled edge-select circuits. After edge-selection the CLOCK, START, and STOP signals are combined to form a gating (gate) control signal. (The external CLOCK signal is also buffered and used to time other sections of the 5004A.) The gate signal is presented on the front panel with a GATE indicator lamp. The gate signal is for on-off (start-stop) control of the word generator.

8-56. Scan/Test Oscillator (Internal Clock)

8-57. A .6 kilohertz signals is generated in the 5004A for display scan and test use. The scan signal controls switching the displays on and off (fast enough to be not noticeable) to lower power consumption and reduce the size of drive circuit components. In the SELF-TEST and NORMAL/SERVICE (troubleshooting) modes the internal test signal is used as a substitute for the external clock normally applied to the gating signals pod.

8-58. Self-Test

8-57. Part of the 5004A is a circuit used only for self-test of the signature analyzer. The self-test function is controlled by a front panel switch. In the self-test mode special signatures are generated using the internal test signal frequency divider output (ROM). If there is a defect in the 5004A the self-test signature will not be correct.

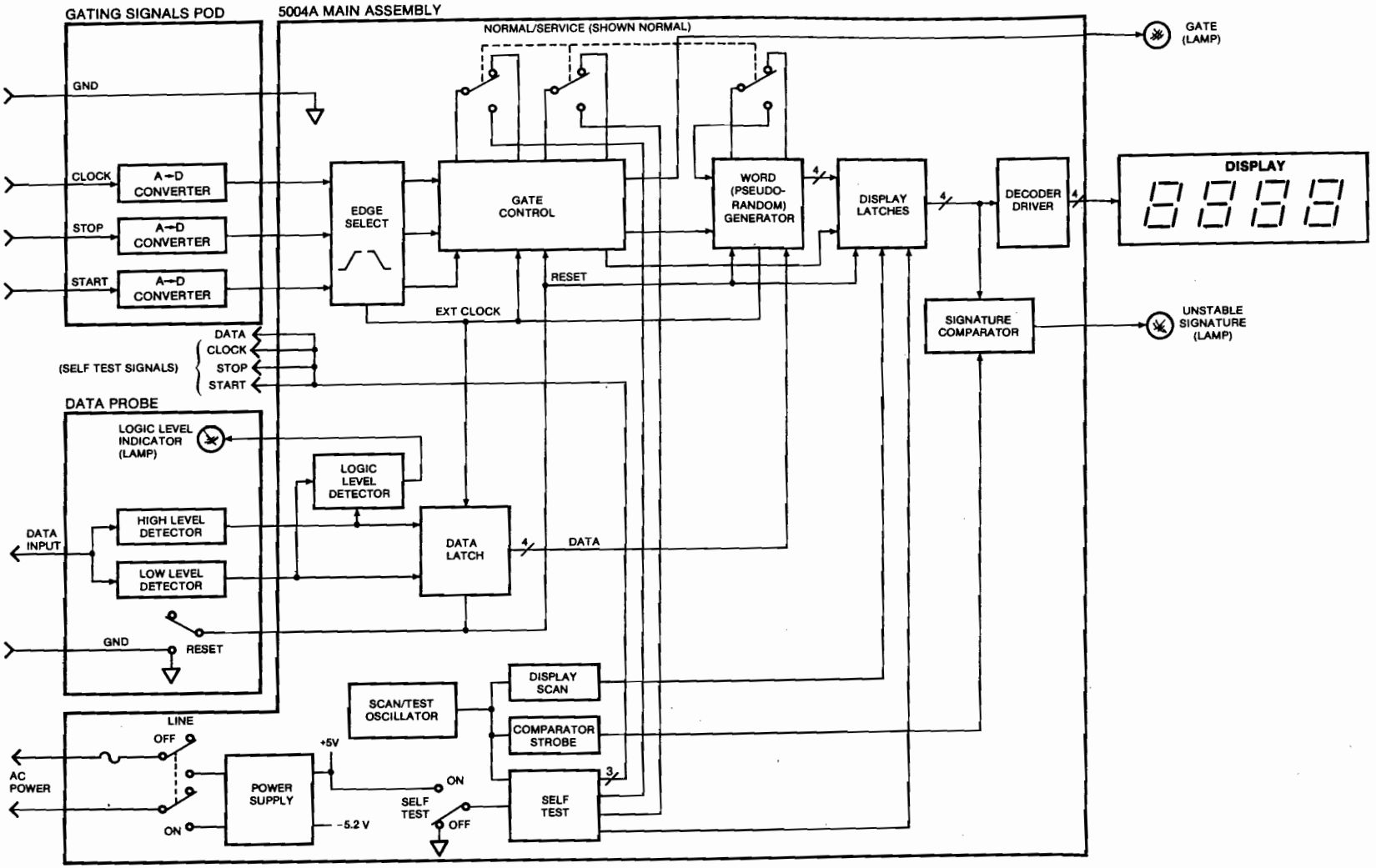


Figure 8–3
5004A CIRCUIT BLOCK DIAGRAM

8-60. Display Scan and Comparator Strobe

8-61. The clock signal is used to time both the display scan and signature compartor strobe circuits. The digit display lamps are enabled less than full-time to conserve power.

NOTE

The NORMAL/SERVICE switch is separate but related to the front panel SELF-TEST switch.

8-62. Service (Troubleshooting) Mode

8-63. On the main assembly of the 5004A a two-position switch, labeled NORMAL/SERVICE, can be used during fault locating (troubleshooting) procedures if the 5004A is not operating correctly.

8-64. Power Supply

8-65. Alternating current line supply (mains) voltage is converted to the two positive and negative regulated direct current voltages required in the 5004A by the power supply circuit.

8-66. CIRCUIT THEORY (PRINCIPLES OF OPERATION)

8-67. The following paragraphs give the circuit theory (principles of operation) for the 5004A Signature Analyzer to explain the schematic diagram. A previous section describes the 5004A at the block diagram level. This BLOCK DIAGRAM DESCRIPTION should be studied and learned before the following paragraphs are studied.

8-68. Purpose of 5004A

8-69. The 5004A Signature Analyzer is designed to be used in testing the correctness of operation of certain complex digital logic electronic instruments or systems. A technique of testing called signature analysis is used with the 5004A and compatible instruments. Refer to the paragraph titled Signature Analysis in Section I for an explanation of signature analysis.

8-70. Schematic Diagram

8-71. The 5004A schematic diagram is presented with the four inputs on the left side, and the flow of signals is generally from the left to the right side where the output indicators are presented. Outputs are four digits (seven-segment LED's) and two single-LED function/condition indicators. Refer to the schematic diagram notes for an explanation of the schematic symbol system used. The ac line power input and dual-voltage (regulated) power supply are on the lower left side of the schematic.

8-72. Gating Signals Pod

8-73. The gating signals pod is the input for the CLOCK, START, and STOP signals to the 5004A. Requirements for these signals are given in Section I. A voltage regulator, U4, for -5.2V on the pod board reduces power dissipation in the main assembly. Amplifier, U1, is used as a voltage follower to provide the 1.4-volt reference level for the three input amplifier-converters. All three input signals are each applied to three separate identical circuits. The input amplifier-converters produce high-speed complementary-output ECL-level signals for the main assembly.

8-74. Edge Selection

8-75. The three ECL-level pulse signals from the pod (START, STOP, and CLOCK) are applied separately to three front-panel switches which may be used to select the polarity of any input signal. Changing the polarity of a signal effectively selects the opposite edge of the input signal as the control for that channel.

8-76. ECL-to-TTL Level Converters

8-77. After the edge select switches the gating signals are applied to four separate ECL-to-TTL level converters. (The CLOCK signal is applied to two separate converters, U12A and B, for two separate paths.) The outputs of the START and STOP level converters are applied to latches which are controlled by the CLOCK signal. The latches outputs are applied to the gate control circuit.

8-78. Gate Control

8-79. The input START and STOP signals are processed in the gate control circuit to produce a definite time window during which data is received by the word generator (described later). Operation of the gate control circuit is described in the following paragraph.

8-80. State Diagram

8-81. *Figure 8-4* is a state diagram of the functioning of the gate control circuits. NOTE: Positive-true logic is used. The INITIAL state normally occurs: when the 5004A has power switched on, or when the data probe RESET switch is pressed, or when a STOP and START pulse are received in RUN mode. In the INITIAL state, if START is 0 the state will change to ARMED. In the ARMED state the 5004A is ready to receive a START pulse and proceed to either RUN mode. (Note that if a STOP pulse is received, the state will be intermediate RUN; and to progress to full RUN, STOP must be 0.) From full RUN the state will return to INITIAL if START and STOP pulses are received. If START remains at 0 and a STOP pulse is received, the state returns to ARMED. The HOLD state occurs when the HOLD switch is in and a STOP pulse is received in the full RUN mode. In the HOLD state, the data probe RESET switch must be pressed to return to the INITIAL state. All modes except HOLD have no-change conditions. For example in the ARMED state if the START line remains at 0, the 5004A will not change to RUN. With proper START, STOP, and CLOCK signals the gate control proceeds through the states repetitively. The gate control circuit output starts and stops the word generator, and provides the on-off control of the GATE lamp to show when the START and STOP signals are received and implemented.

8-82. Data Signal Flow

8-83. In normal operation, data signals from the unit being tested are applied to the 5004A high-speed data probe. The data probe (A3) discriminates whether the input TTL level is high or low or bad (middle level). If the input level is high it is detected by U1A, if it is low it is detected by U1B. The input signal is converted to a pair of two-line differential (complementary) ECL signals and sent to the main assembly. At the input to the main assembly the data signal is converted from a pair of two-line (differential) ECL signals to a pair of signals at TTL level.

8-84. The pair of data signals at pins 6 and 12 of U11 (A and B) are applied to the data latch, U9. If the data input signal is a high level or a low level it is clocked out of the data latch on pin 5. If it is a bad (middle) level signal the previous level signal is clocked out of the data latch. (A bad level appears as tow lows at the U9J and K inputs.)

8-85. In the main assembly the data TTL signals at the junction of R37 and R38 are applied to U20, a logic level detector. The detector responds to the combined TTL level (or pulses) of the input signal, and it controls the indication of the logic level indicator lamp, DS1, in the data probe. The two TTL data signals are applied to the data latch, J9. Data from U9(5) is applied to U6(5), an "exclusive-OR" gate. This is the input of the pseudo-random word generator.

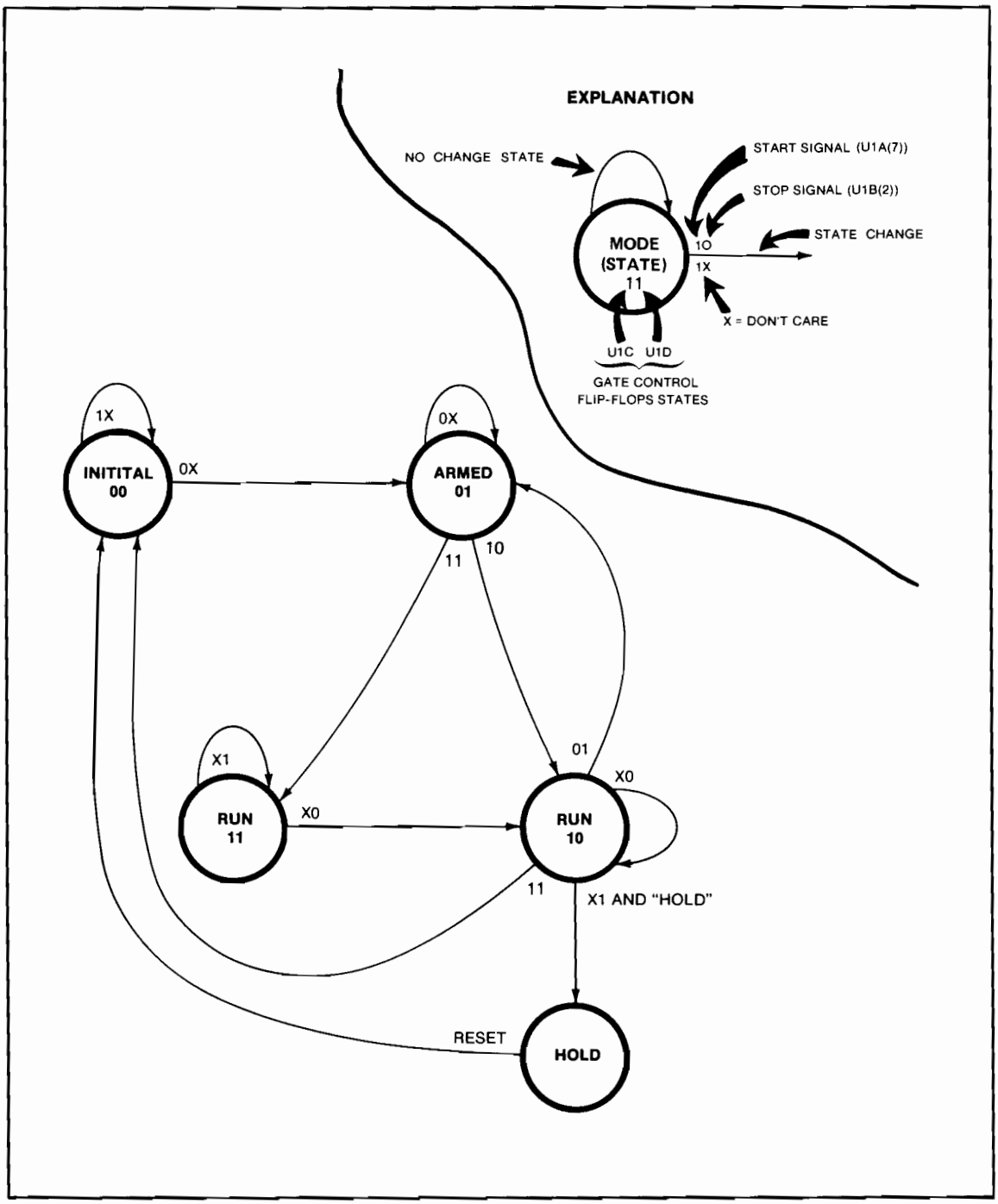


Figure 8-4. Gate Control State Diagram

8-86. Pseudo-Random Word Generator (Data Signal Path Continued)

8-87. The pseudo-random word generator is the central principle of the signature analysis method. A shift register with some outputs fed back is used to generate a pseudo-random word (signature) output. Input data goes through U6 to shift register U21. From U21(13) the data goes to U24(1 and 2) input. One output from U21 (pin 12) and three outputs from U24 (pins 3, 6, and 13) are fed back to the U6 inputs to combine with the input data and modify the resultant output of the shift registers. The outputs of the two shift registers (U24 and U21) are the unique "signatures."

8-88. Display Control (Data Signal Path Continued)

8-89. The 16-line signature output of the word generator is applied to the inputs of registers U15, U16, U13, and U14 which drive U19 a memory used as a character decoder. The output of U19 is applied to the four LED seven-segment digits on the display assembly.

8-90. Signature Comparator (UNSTABLE Signature Lamp)

8-91. As each signature is applied to the character decoder, U19, it is also stored in memory U22. When the next signature is received it is compared with the previous signature in U23. If the two signatures are different, U23 outputs a pulse to U7A which is sent to pulse-on the UNSTABLE SIGNATURE lamp on the display assembly, A2. If succeeding signals are identical, U23 does not send a pulse to the lamp. The comparator receives a low-frequency strobe signal from U18B which controls the timing of a store and compare cycle.

8-92. Scan/Test Oscillator

8-93. U28 is a low-frequency (.6 Khz) square wave oscillator. The output of U28 is used for the test circuit and to scan the displays.

8-94. Display Scan

8-95. The front-panel-swiched self-test circuit includes U27, U25, U29, and U17. The four-bit counters, U27 and U25 are cycled by a signal from the self-test oscillator, U28, through U26. Outputs of U27 and U26 address memory U29 which supplies START and STOP signals in the self-test mode. All possible states of the gate control circuit are exercised in each self-test cycle to check proper operation. Self-test signals are applied to the inputs of the 5004A to allow all circuits to be tested. Part of the test besides specific signatures is to apply trash to U17 which will exercise all seven segments of each display digit.

8-98. NORMAL/SERVICE Test Switch

8-99. The NORMAL/SERVICE test switch on the main assembly allows all feedback paths in the 5004A to be opened for complete signature analysis testing, with a second 5004A Signature Analyzer. (Refer to the troubleshooting procedures in this section.)

8-100. INPUT SIGNAL TIMING

8-101. *Figure 8-5* shows the timing relationship between the input, CLOCK, START, DATA, and STOP signals. The diagram shows that the START signal must transition from low to high before the gate will open, and data in the middle level is accepted as the preceding condition.

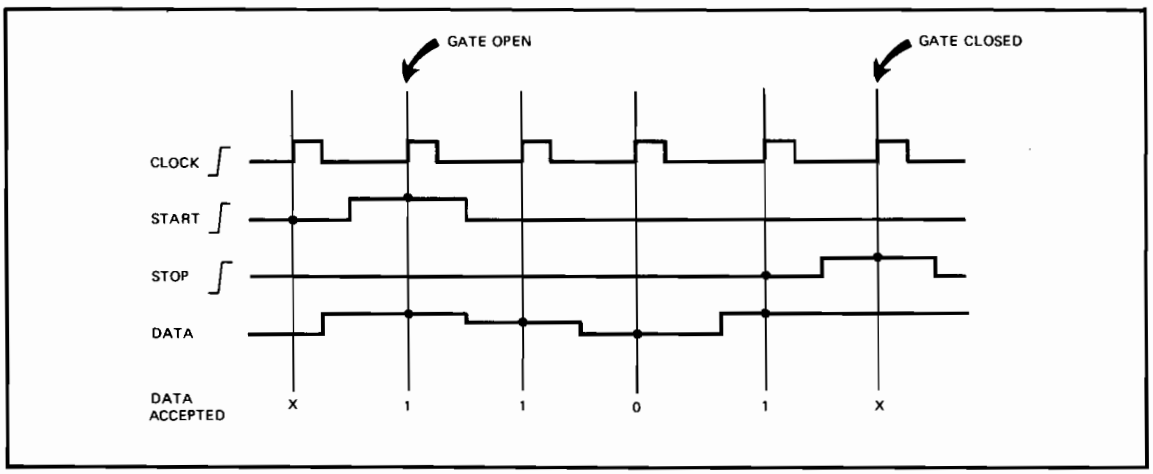


Figure 8-5. Input Signals Timing

SCHEMATIC DIAGRAM NOTES

Resistance in ohms, capacitance in picofarads, inductance in millihenries unless otherwise noted.

* Asterisk denotes a factory-selected value. Value shown in typical. Part may be omitted.

Tool-aided adjustment. ○ Manual control.

Encloses front-panel caption.

Encloses rear-panel caption.

Encloses interior or printed-circuit board caption.

Circuit assembly borderline.

Other assembly borderline. Also used to indicate mechanical interconnection (ganging).

CW Wiper moves toward CW with clockwise rotation of control (as viewed from shaft or knob).

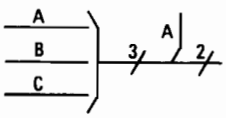
1 Numbered Test Point. Measurement aid provided

A Lettered Test Point. No measurement aid provided.

A direct conducting connection to the earth, or a conducting connection to a structure that has a similar function (e.g., the frame of an air, sea, or land vehicle).

A conducting connection to a chassis or frame.

Common connections. All like-designated points are connected.



Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.

Integrated Circuit Power Terminals

Unless noted otherwise*, +5 volts is applied to each integrated circuit as given below:

14-Pin Units	Power	16-Pin Units
Pin 14	+5V	Pin 16
Pin 7	Return	Pin 8
Exceptions U25, U26, U27		
Pin 14	+5V	
Pin 10	Return	

NOTE

Several integrated circuits use the -5.2V power. The -5.2V pins are shown on the schematic diagram.

Figure 8-6. Schematic Diagram Notes

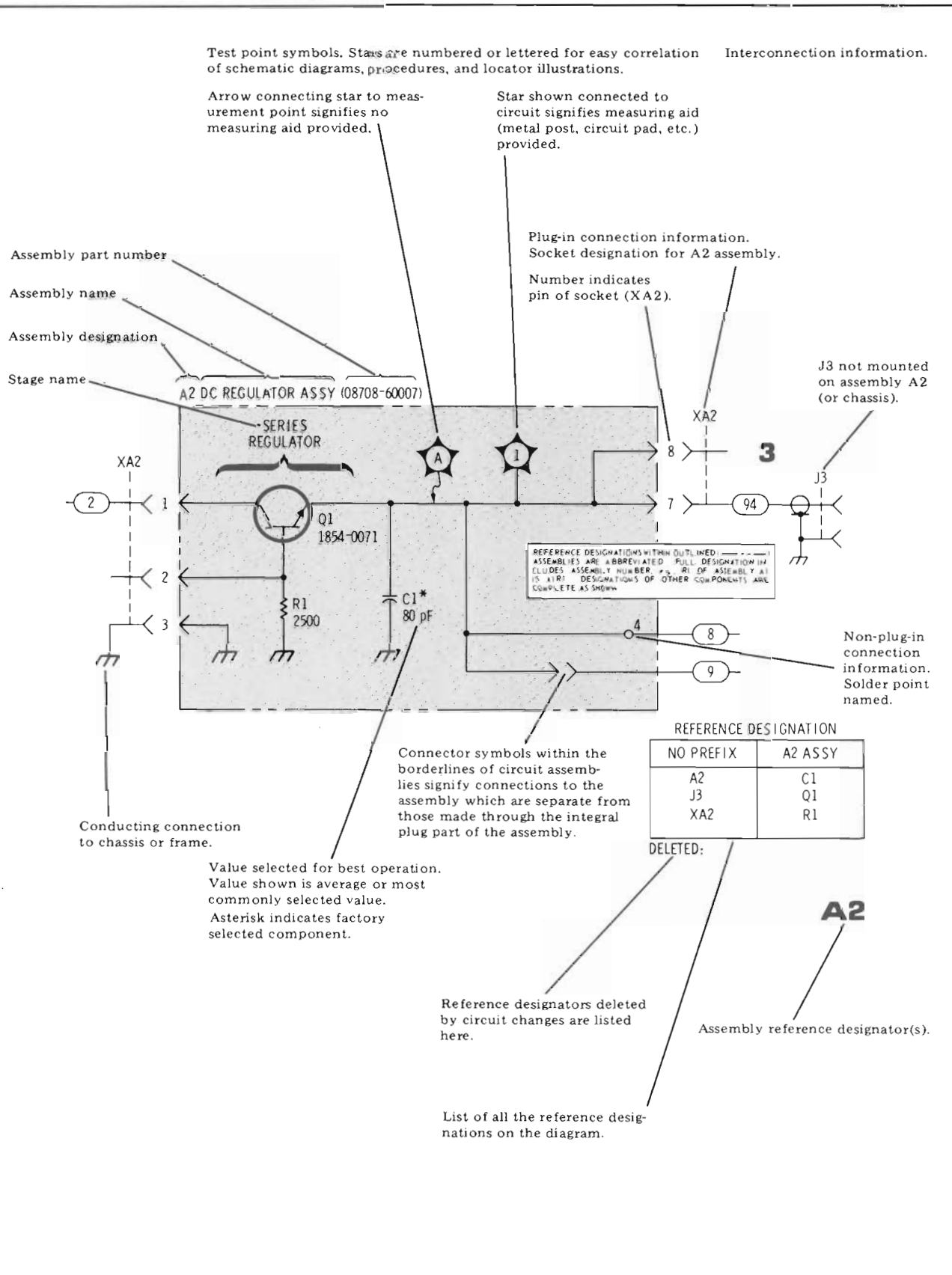


Figure 8-6. Schematic Diagram Notes (Continued)

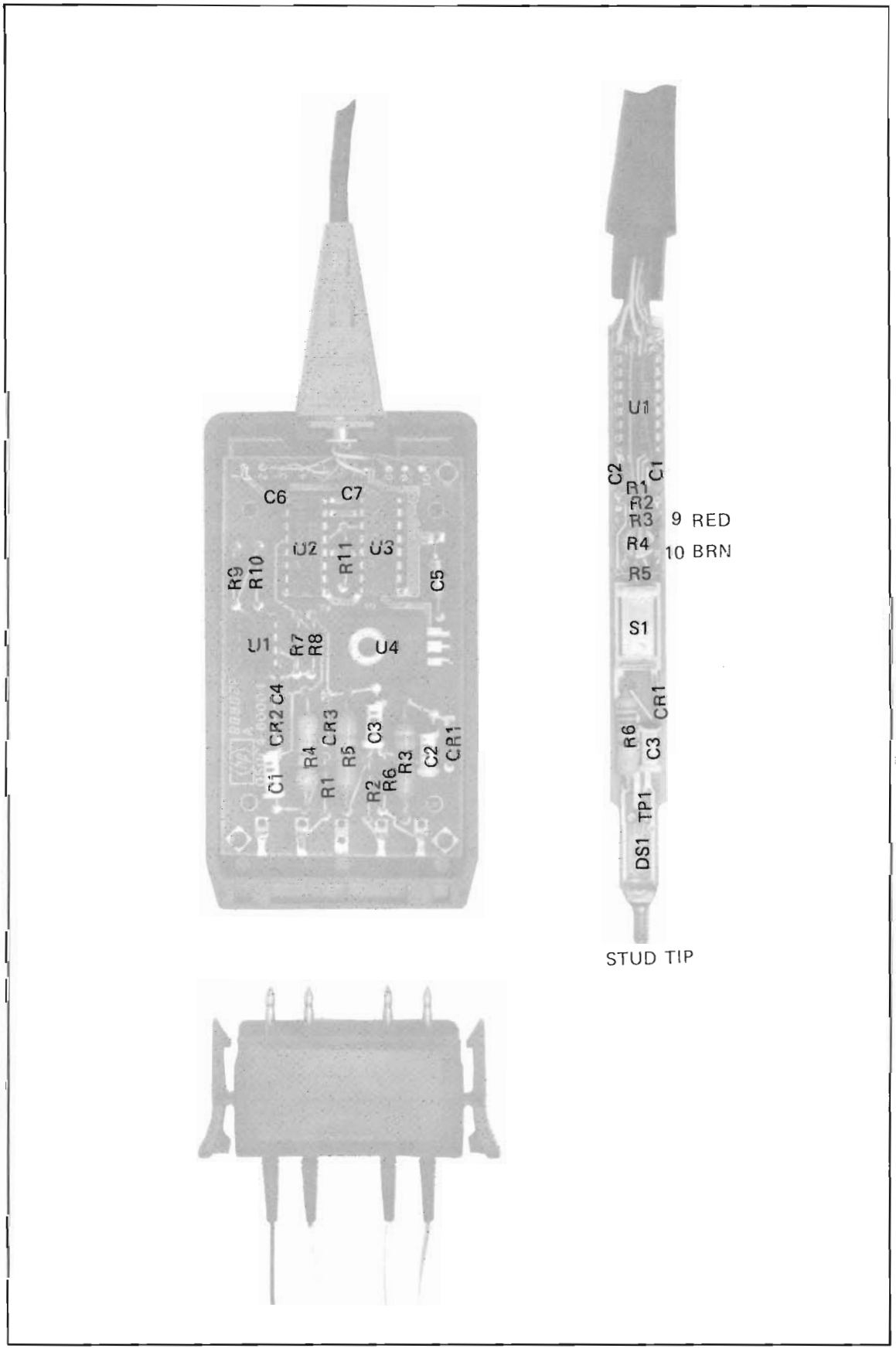


Figure 8-7. Probe and Pod (A3 and A4) Component Locations

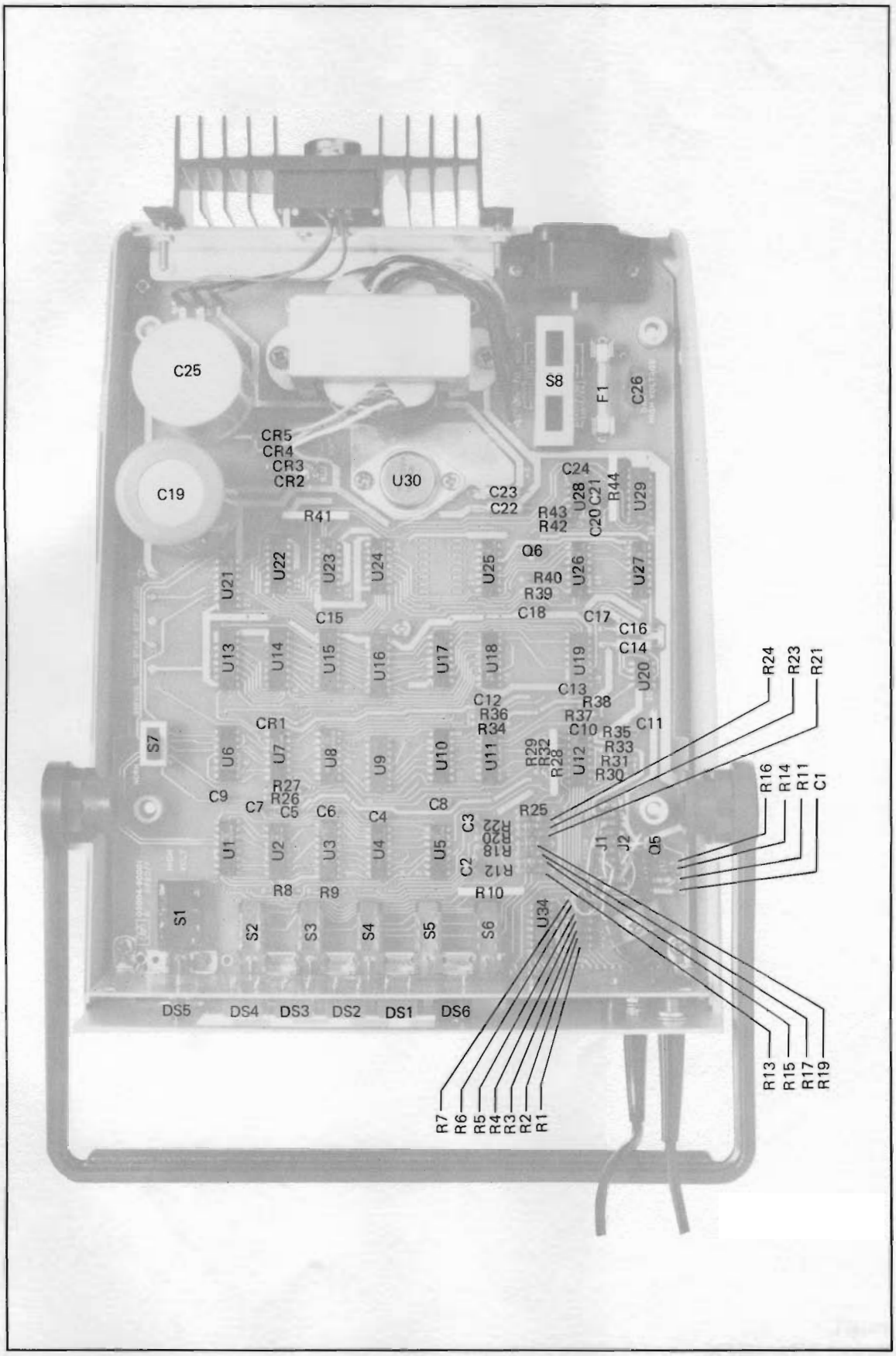
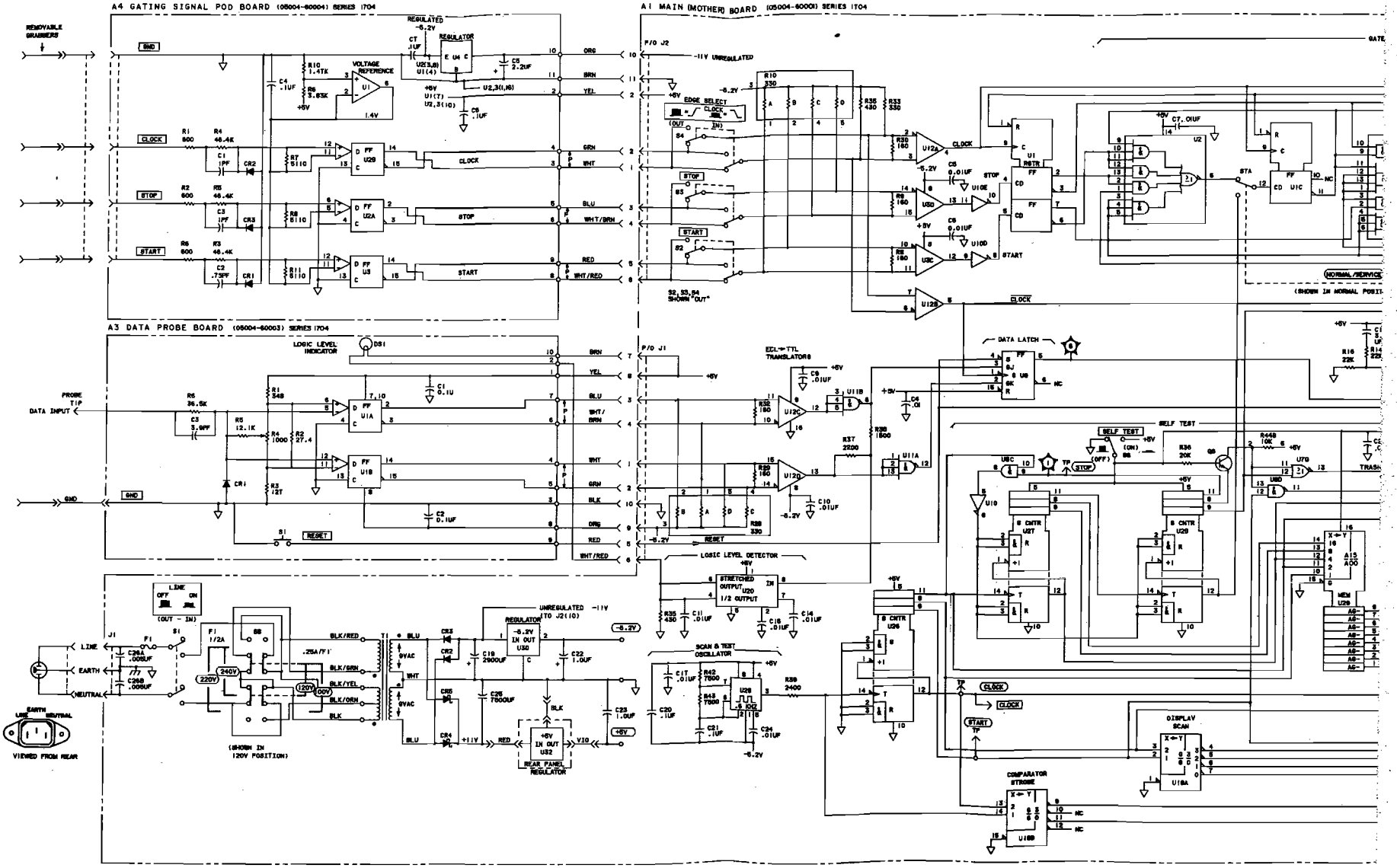


Figure 8–8. Display Board and Main Board (A1) Component Locations


A4 GATING SIGNAL POD BOARD (05004-60004) SERIES 1704
A1 MAIN (MOTHER) BOARD (05004-60001) SERIES 1704
A3 DATA PROBE BOARD (05004-60003) SERIES 1704
REMOVABLE GRABBERS
GND
CLOCK
STOP
START
REGULATED -6.2V
REGULATOR
VOLTAGE REFERENCE
ORG
BRN
YEL
GRN
WHT
BLU
WHT/BRN
RED
WHT/RED
P/O J2
-11V UNREGULATED
EDGE SELECT
S4
S3
S2
S2,S3,S4 SHOWN "OUT"
DATA LATCH
SELF TEST
NORMAL/SERVICE
(SHOWN IN NORMAL POSITION)
PROBE TIP DATA INPUT
LOGIC LEVEL INDICATOR
P/O J1
ECL-TTL TRANSLATORS
LOGIC LEVEL DETECTOR
STRETCHED OUTPUT
1/2 OUTPUT
RESET
LINE
EARTH
NEUTRAL
LINE ON
(OUT - IN)
240V
220V
120V
100V
.25A/T
UNREGULATED -11V (TO J2(10))
REGULATOR
REAR PANEL REGULATOR
SCAN & TEST OSCILLATOR
(SHOWN IN 120V POSITION)
VIEWED FROM REAR
COMPARATOR STROBE
DISPLAY SCAN

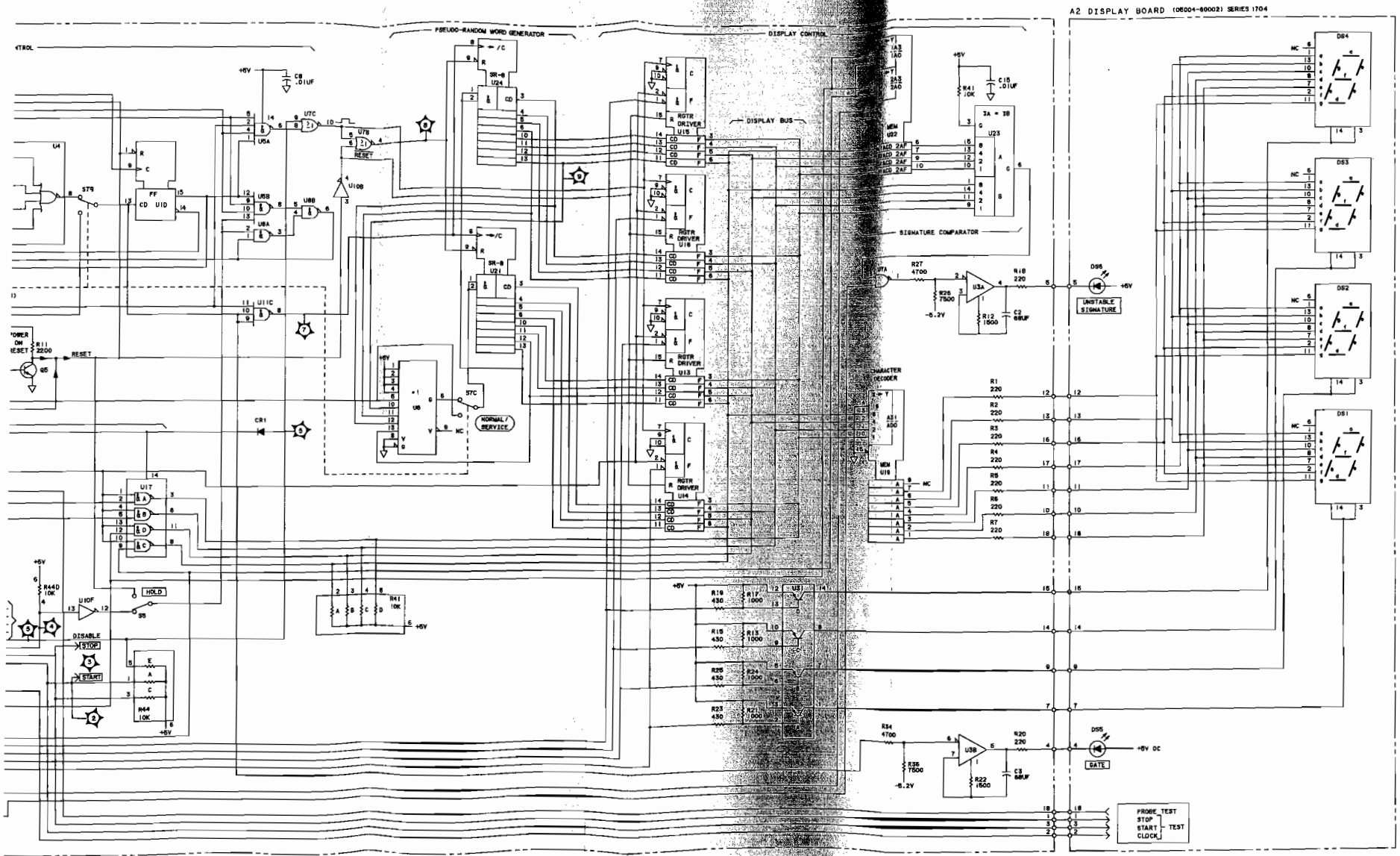


Figure 8-9. Schematic Diagram

HEWLETT hp PACKARD

SALES & SERVICE OFFICES

AFRICA, ASIA, AUSTRALIA

AMERICAN SAMOA
Calculators Only
Oceanic Systems Inc
P.O. Box 777
Pago Pago Bayfront Road
Pago Pago 96799
Tel: 633-5513
Cable: OCEANIC-Pago Pago

ANGOLA
Telectra
Empresa Técnica de Equipamentos Eléctricos, S.A.R.L.
R. Barbosa Rodrigues, 42-1°DT°
Caixa Postal, 6487
Luanda
Tel: 35515/6
Cable: TELECTRA Luanda

AUSTRALIA
Hewlett-Packard Australia Pty. Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
P.O. Box 36
Doncaster East, Victoria 3109
Tel: 89-6351
Telex: 31-024
Cable: HEWPARD Melbourne

Hewlett-Packard Australia Pty. Ltd.
31 Bridge Street
Pymble
New South Wales, 2073
Tel: 449-6566
Telex: 21561
Cable: HEWPARD Sydney

Hewlett-Packard Australia Pty. Ltd.
153 Greenhill Road
Parkside, 5063, S.A.
Tel: 272-5911
Telex: 82536 AOEL
Cable: HEWPARD ADELAIDE

Hewlett-Packard Australia Pty. Ltd.
141 Stirling Highway
Nedlands, W.A. 6009
Tel: 86-5455
Telex: 93859 PERTH
Cable: HEWPARD PERTH

Hewlett-Packard Australia Pty. Ltd.
121 Wollongong Street
Fyahwick, A.C.T. 2609
Tel: 95-3733
Telex: 62650 Canberra
Cable: HEWPARD CANBERRA

Hewlett Packard Australia Pty. Ltd.
5th Floor
Teachers Union Building
495-499 Boundary Street
Spring Hill, 4000 Queensland
Tel: 29-1544
Telex: 42133 BRISBANE

GUAM
Medical/Pocket Calculators Only
Guam Medical Supply, Inc.
Jay Ease Building, Room 210
P.O. Box 8947
Tamuning 96911
Tel: 646-4513
Cable: EARMED Guam

HONG KONG
Schmidt & Co.(Hong Kong) Ltd
P.O. Box 297
Connalight Centre
39th Floor
Connaught Road, Central
Hong Kong
Tel: H-255291-5
Telex: 74766 SCHMC HX
Cable: SCHMIDTCO Hong Kong

INDIA
Blue Star Ltd
Kasturi Buildings
Jamshedji Tata Rd.
Bombay 400 020
Tel: 29 50 21
Telex: 2156
Cable: BLUEFROST

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
Bombay 400 025
Tel: 45 78 87
Telex: 4093
Cable: FROSTBLUE

Blue Star Ltd
Band Box House
Prabhadevi
Bombay 400 025
Tel: 45 73 01
Telex: 3751
Cable: BLUESTAR

Blue Star Ltd
14/40 Civil Lines
Kanpur 208 001
Tel: 6 88 82
Telex: 292
Cable: BLUESTAR

Blue Star Ltd.
7 Hare Street
P.O. Box 506
Calcutta 700 001
Tel. 23-0131
Telex: 7655
Cable: BLUESTAR

Blue Star Ltd.
7th & 8th Floor
Bhandari House
91 Nehru Place
New Delhi 110024
Tel: 634770 & 635166
Telex: 2463
Cable: BLUESTAR

Blue Star Ltd.
Blue Star House
11/11A Magarath Road
Bangelore 560 025
Tel: 55668
Telex: 430
Cable: BLUESTAR

Blue Star Ltd.
Meeakshi Mandiran
xxx/1678 Mahatma Gandhi Rd
Cochin 682 016 Kerala
Tel: 32069, 32161, 32282
Telex: 046-514
Cable: BLUESTAR

Blue Star Ltd
1-1-117/1
Sarojini Devi Road
Secunderabad 500 003
Tel: 70126, 70127
Cable: BLUEFROST
Telex: 459

Blue Star Ltd
2/34 Kodambakkan High Road
Madras 600034
Tel. 82056
Telex: 041-379
Cable: BLUESTAR

Blue Star Ltd
Nathraj Mansions
2nd Floor Bistupur
Jamshedpur 831 001
Tel: 7383
Cable: BLUESTAR
Telex: 240

INDONESIA
BERCA Indonesia P.T.
P.O. Box 496
1st Floor JL. Cikini Raya 61
Jakarta
Tel: 56038, 40369, 49886
Telex: 42895
Cable: BERCACON

BERCA Indonesia P.T.
63 JL. Raya Gubeng
Surabaya
Tel: 44309

ISRAEL
Electronics & Engineering Div of Motorola Israel Ltd
16, Kremenetski Street
P.O. Box 25016
Tel-Aviv
Tel: 03-389 73
Telex: 33569
Cable: BASTEL Tel-Aviv

JAPAN
Yokogawa-Hewlett-Packard Ltd
Ohashi Building
1-59-1 Yoyogi
Shibuya-ku, **Tokyo**
Tel: 03-370-2281/92
Telex: 232-2024YHP
Cable: YHPMARKET TOK 23-724

Yokogawa-Hewlett-Packard Ltd
Nissei Ibaraki Building
2-8 Kasuga 2-chome, Ibaraki-shi
Osaka 567
Tel: (0726) 23-1641
Telex: 5332-385 YHP OSAKA

Yokogawa-Hewlett-Packard Ltd
Nakamo Building
24 Kami Sasajima-cho
Nakamura-ku, **Negoya**, 450
Tel: (052) 571-5171

Yokogawa-Hewlett-Packard Ltd
Tamigawa Building
2-24-1 Tsuruya-choo.
Kanagawa-ku
Yokohama, 221
Tel: 045-312-1252
Telex: 382-3204 YHP YOK

Yokogawa-Hewlett-Packard Ltd
Mito Mitsui Building
105, 1-chrome, San-no-maru
Mito, Ibaragi 310
Tel: 0292-25-7470

Yokogawa-Hewlett-Packard Ltd
Inoue Building
1348-3, Asahi-cho, 1-chome
Atsugi, Kanagawa 243
Tel: 0462-24-0452

Yokogawa-Hewlett-Packard Ltd.
Inoue Building
1348-3, Asahi-cho, 1-chome
Atsugi, Kanagawa 243
Tel: 0462-24-0452

Yokogawa-Hewlett-Packard Ltd.
Kimura Building
3rd Floor 20
2-chome, Tsukuba
Kumegays, Saitama 360
Tel: 0485-24-6563

KENYA
Technical Engineering Services (E.A.)Ltd.,
P.O. Box 18311
Nairobi
Tel: 557726/556762
Cable: PROTON

Medical Only
International Aeradio(E.A.)Ltd.,
P.O. Box 19012
Nairobi Airport
Nairobi
Tel: 336055/56
Telex: 22201/22301

KOREA
Samsung Electronics Co., Ltd.
20th Fl. Dongbang Bldg. 250,
2-KA, C.P.O. Box 2775
Taepyung-Ro, Chung-Ku
Seoul
Tel: (24) 2410-9
Telex: 22575

MALAYSIA
Teknik Mutu Sdn. Bhd
2 Lorong 13/6A
Section 13
Petaling Jaya **Selangor**
Tel: Kuala Lumpur-54994
Telex: **MA** 37505

Protel Engineering
P.O. Box 1917
Lot 259, Satok Road
Kuching, **Serawak**
Tel: 2400

MOZAMBIQUE
A.N. Goncalves, Lta.
162, 1° Apt. 14 Av. D. Luis
Caixa Postal 107
Lourenco Marques
Tel: 27091, 27114
Telex: 6-203 Negon Mo

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd
4-12 Cruickshank Street
Kilbirnie, Wellington 3
Mailing Address: Hewlett-Packard (N.Z.) Ltd
P.O. Box 9443
Courtney Place
Wellington
Tel: 877-199
Telex: NZ 3839
Cable: HEWPACK Wellington

Hewlett-Packard (N.Z.) Ltd
Pakuranga Professional Centre
267 Pakuranga Highway
Box 51092
Pakuranga
Tel: 569-651
Telex: NZ 3839
Cable: HEWPACK,Auckland

Analytical/Medical Only
Medical Supplies N.Z. Ltd
Scientific Division
79 Carlton Gore Rd., Newmarket
P.O. Box 1234
Auckland
Tel: 75-289
Telex: 2958 MEDISUP
Cable: DENTAL Auckland

Analytical/Medical Only
Medical Supplies N.Z. Ltd
P.O. Box 1994
147-161 Tory St
Wellington
Tel: 850-799
Telex: 3858
Cable: DENTAL, Wellington

Analytical/Medical Only
Medical Supplies N.Z. Ltd
P.O. Box 309
239 Stanmore Road
Christchurch
Tel: 892-019
Cable: DENTAL, Christchurch

Analytical/Medical Only
Medical Supplies N.Z. Ltd
303 Great King Street
P.O. Box 233
Dunedin
Tel: 88-817
Cable: DENTAL, Dunedin

NIGERIA
The Electronics Instrumentations Ltd
N6B/770 Oyo Road
Oluseun House
P.M.B. 5402
Ibadan
Tel: 61577
Telex: 31231 TEIL Nigeria
Cable: THETEIL Ibadan

The Electronics Instrumentations Ltd
144 Agege Motor Road, Mushin
P.O. Box 6645
Lagos
Cable: THETEIL Lagos

PAKISTAN
Mushko & Company, Ltd
Oosman Chambers
Abdullah Haroon Road
Karachi-3
Tel: 511027, 512927
Telex: KR894
Cable: COOPERATOR Karachi

Mushko & Company, Ltd
38B, Satellite Town
Rawalpindi
Tel: 41924
Cable: FEMUS Rawalpindi

PHILIPPINES
The Online Advanced Systems Corporation
Filcapital Bldg
11th Floor, Ayala Ave
Makati, **Rizal**
Tel: 85-34-91, 85-35-81
Telex: 3274 ONLINE

RHODESIA
Field Technical Sales
45 Kelvin Road North
P.O. Box 3458
Salisbury
Tel: 705231 (5 lines)
Telex: RH 4122

SINGAPORE
Hewlett-Packard Singapore (Pte.) Ltd
Blk. 2, 6th Floor, Jalan Bukit Merah
Redhill Industrial Estate
Alexandra P.O. Box 58,
Singapore 3
Tel: 633022
Telex: HPSG RS 21486
Cable: HEWPACK, Singapore

SOUTH AFRICA
Hewlett-Packard South Africa (Pty.) Ltd
Private Bag Wendywood
Sandton, Transvaal 2144
Hewlett-Packard House
Daphne Street, Wendywood,
Sandton, Transvaal 2144
Tel: 802-104016
Telex: SA43-4782JH
Cable: HEWPACK JOHANNESBURG

Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 120
Howard Place, Cape Province, 7450
Pine Park Center, Forest Drive,
Pinelands, Cape Province, 7405
Tel: 53-7955 thu 9
Telex: 57-0006

Hewlett-Packard South Africa (Pty.), Ltd.
P.O. Box 37099
Overport, Durban 4067
641 Ridge Road, Durban
Durban, 4001
Tel: 88-7478/9
Telex: 6-7954
Cable: HEWPACK

TAIWAN
Hewlett-Packard Far East Ltd.,
Taiwan Branch
39 Chung Shiao West Road
Sec. 1, 7th Floor
Taipei
Tel: 3819160-4 (5 Lines)
Telex: 21824 HEWPACK
Cable: HEWPACK TAIPEI

Hewlett-Packard Far East Ltd
Taiwan Branch
68-2, Chung Cheng 3rd Road
Kaohsiung
Tel: (07) 242318-Kaohsiung

Analytical Only
San Kwang Instruments Co., Ltd
No. 20, yung Sui Road
Taipei, 100
Tel: 3715171-4 (5 lines)
Telex: 22894 SANKWANG
Cable: SANKWANG TAIPEI

TANZANIA
Medical Only
International Aeradio (E.A.) Ltd
P.O. Box 861
Daressalaam
Tel: 21251 Ext. 265
Telex: 41030

THAILAND
UNIMESA Co., Ltd.
Elcom Research Building
Bangjak Sukumvit Ave
Bangkok
Tel: 932387, 930338
Cable: UNIMESA Bangkok

UGANDA
Medical Only
International Aeradio(E.A.) Ltd
P.O. Box 2577
Kampala
Tel: 54388
Cable: INTAERIO Kampala

ZAMBIA
R.J. Tilbury (Zambia) Ltd
P.O. Box 2792
Lusaka
Tel: 73793
Cable: ARJAYTEE, Lusaka

OTHER AREAS NOT LISTED, CONTA
Hewlett-Packard Intercontinental
3200 Hillview Ave
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd
11620A - 168 Street
EdmontonT5M 3T9
Tel: (403) 452-3670
TWX: 610-831-2431 EDTH

Hewlett-Packard (Canada) Ltd.
915-42 Ave S.E. Suite 102
Calgary T2G 1Z1
Tel: (403) 287-1672
Twx: 610-821-6141

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd
837 E. Cordova Street
Vancouver V6A 3R2
Tel: (604) 254-0531
TWX: 610-922-5059 VCR

MANITOBA
Hewlett-Packard (Canada) Ltd
513 Century St
St. James
Winnipeg R3H 0L8
Tel: (204) 786-7581
TWX: 610-671-3531

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd
800 Windmill Road
P.O. Box 9331
Dartmouth B2Y 3Z6
Tel: (902) 469-7820
TWX: 610-271-4482 HFX

ONTARIO
Hewlett-Packard (Canada) Ltd
1785 Woodward Dr
Ottawa K2C 0P9
Tel: (613) 225-6530
TWX: 610-562-8968

Hewlett-Packard (Canada) Ltd
6877 Goreway Drive
Mississauga L4V 1M8
Tel: (416) 678-9430
TWX: 610-492-4246

QUEBEC
Hewlett-Packard (Canada) Ltd
275 Hymus Blvd
Pointe Claire H9R 1G7
Tel: (514) 697-4232
TWX: 610-422-3022
TLX: 05-821521 HPCL

FOR CANADIAN AREAS NOT LISTI
Contact Hewlett-Packard (Canada) Ltd. in Mississauga

CENTRAL AND SOUTH AMERICA

ARGENTINA
Hewlett-Packard Argentina S.A.
Av. Leandro N. Alem 822 - 12°
1001**Buenos Aires**
Tel: 31-6063,4,5,6 and 7
Telex: Public Booth N° 9
Cable: HEWPACK ARG

BOLIVIA
Stambuk & Mark (Bolivia) Ltda
Av. Mariscal, Santa Cruz 1342
La Paz
Tel: 40626, 53163, 52421
Telex: 3560014
Cable: BUKMAR

BRAZIL
Hewlett-Packard do Brasil I.E.C. Ltda.
Avenida Rio Negro, 980
Alphaville
06400 Barueria Sao Paulo
Tel: 429-2148/9;429-2118/9

Hewlett-Packard do Brasil I.E.C. Ltda.
Rua Padre Chagas, 32
90000-Pôrto Alegre-RS
Tel: (0512) 22-2998, 22-5621
Cable: HEWPACk porto Alegre

Hewlett-Packard do Brasil I.E.C. Ltda
Rua Siqueira Campos, 53, 4° andar-Copacabana
20000-**Rio de Janeiro**-GB
Tel: 257-80-94-DDD (021)
Telex: 391-212-1905 HEWP-BR
Cable: HEWPACK Rio de Janeiro

CHILE
Calcagni y Metcalfe Ltda
Alameda 580-Of. 807
Casilla 2118
Santiago, 1
Tel: 398613
Telex: 3520001 CALMET
Cable: CALMET Santiago

Medical Only
General Machinery Co., Ltda
Paraguay 494
Casilla 13910
Santiago
Tel: 31123, 31124
Cable: GEMCO Santiago

COLOMBIA
Instrumentación
Henrik A. Langebaek & Kier S.A.
Carrera 7 No. 48-75
Apartado Aéreo 6287
Bogotá, D.E.
Tel: 69-88-77
Cable: AARIS Bogotá
Telex: 044-400

COSTA RICA
Científica Costarricense S.A.
Calle Central, Avenidas 1 y 3
Apartado 10159
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Medical Only
A.F. Viscaino Compañía Ltda
Av. Rio Amazonas No. 239
P.O. Box 2925
Quito
Tel: 242-150,247-033/034
Cable: Astor Quito

Calculators Only
Computadoras y Equipos Electrónicos
P.O. Box 2695
990 Toledo (y Cordero)
Quito
Tel: 525-982
Telex: 02-2113 Sagita Ed
Cable: Sagita-Quito

EL SALVADOR
Instrumentacion y Procesamiento Electronico de el Salvador
Bulevar de los Heroes II-48
San Salvador
Tel: 252787

GUATEMALA
IPESA
Avenida La Reforma 3-48, Zona 9
Guatemala City
Tel: 63627, 64786
Telex: 4192 Teletro Gu

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Torres Adalid No. 21, 11° Piso
Col. del Valle
Mexico 12, D.F.
Tel: (905) 543-42-32
Telex: 017-74-507

Hewlett-Packard Mexicana, S.A. de C.V.
Ave. Constitucidn No. 2184
Monterrey, N.L.
Tel: 48-71-32, 48-71-84
Telex: 038-843

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 25114, 23412,23454
Cable: ROTERAN Managua

PANAMA
Electrónico Balboa, S.A.
P.O. Box 4929
Calle Samuel Lewis
Ciudad de Panama
Tel: 64-2700
Telex: 3431103 Curunda, Canal Zone
Cable: ELECTRON Panama

PARAGUAY
C.A. Melamed S.R.L.
División: Aparatos y Equipos Médicos
División: Aparatos y Equipos Científicos y de Investigación
P.O. Box 676
Chile-482, Edificio Victoria
Asunción
Tel: 4-5069, 4-6272
Cable: RAMEL

PERU
Compañía Electro Médica S.A.
Los Flamencos 145
San Isidro Casilla 1030
Lima 1
Tel: 41-4325
Cable: ELMEO Lima

PUERTO RICO
Hewlett-Packard Inter-Americas
Puerto Rico Branch Office
Calle 272, Urb. Country Club
Carolina 00639
Tel: (809) 762-7355/7455/7655
Telex: HPIC-PR 3450514

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard de Venezuela C.A.
Apartado 50933, Caracas 105
Edificio Segre
Tercera Transversal
Los Ruices Norte
Caracas 107
Tel: 35-01-07, 35-00-84, 35-00-65, 35-00-31
Telex: 25146 HEWPACK
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED, CONTAC
Hewlett-Packard
Inter-Americas
3200 Hillview Ave
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1260
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

EUROPE, NORTH AFRICA AND MIDDLE EAST

AUSTRIA
Hewlett-Packard Ges.m.b.H.
Handelskai 52
P.O. box 7
A-1205 **Vienna**
Tel: (0222) 35 16 21 to 27
cable: HEWPAK Vienna
Telex: 75923 hewpak a

BELGIUM
Hewlett-Packard Benelux
S.A./N.V.
Avenue de Col-Vert, 1,
(Groenkraaglaan)
B-1170 **Brussels**
Tel: (02) 672 22 40
Cable: PALOBEN Brussels
Telex: 23 494 paloben bru

CYPRUS
Kypronics
19, Gregorios & Xenopoulos Rd.
P.O. Box 1152
CY-**Nicosia**
Tel: 45628/29
Cable: KYPRONICS PANDEHIS
Telex: 3018

CZECHOSLOVAKIA
Vyvojova a Provozni Zakladna
Vyzkumnych Ustavu v Bechovicich
CSSR-25097
Bechovice u Prahy
tel: 89 93 41
Telex: 121333

DDR
Entwicklungslabor der TU Dresden
Forschungsinstitut Meinsberg
DDR-7305
Waldheim/Meinsberg
Tel: 37 667
Telex: 518741
Firma Forgber
Schlegelstrasse 15
1040 **Berlin**
Tel: 28 27 411
Telex: 112889

DENMARK
Hewlett-packard A/S
Datavej 52
DK-3460 **Birkerød**
Tel: (02) 81 66 40
Cable: HEWPACK AS
Telex: 166 40 hpas
Hewlett-Packard A/S
Navervej 1
DK-8600 **Silkeborg**
Tel: (06) 82 71 66
Telex: 166 40 hpas
Cable: HEWPACK AS

FINLAND
Hewlett-Packard OY
Nahkahuosuntie 5
P.O. Box 6
SF-0021 **Helsinki** 21
Tel: 6923031
Cable: HEWPACKOY Helsinki
Telex: 12-1563

FRANCE
Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
F-91401 **Orsay** Cédex
Tel: (1) 907 78 25
Cable: HEWPACK Orsay
Telex: 600048
Hewlett-Packard France
"Le Saquin"
Chemin des Mouilles
Boite Postale No. 12
F-69130 **Ecully**
Tel: (78) 33 81 25,
Cable: HEWPACK Eculy
Telex: 310617
Hewlett-Packard France
Agence Régionale
Péricentre de la Cépière
Chemin de la Cépière, 20
F-31300 **Toulouse-Le Mirail**
Tel:(61) 40 11 12
Cable: HEWPACK 51957
Telex: 510957
Hewlett-Packard France
Agence Régionale
Aéroport principal de
Marseille-Marignane
F-13721**Marignane**
Tel: (91) 89 12 36
Cable: HEWPACK MARGN
Telex: 410770
Hewlett-Packard France
Agence Régionale
63, Avenue de Rochester
Boîte Postale
F-35014 **Rennes** Cédex
Tel: (99) 36 33 21
Cable: HEWPACK 74912
Telex: 740912
Hewlett-Packard France
Agence Régionale
74, Allée de la Robertsau
F-67000 **Strasbourg**
Tel: (88) 35 23 20/21
Telex: 890141
Cable: HEWPACK STRBG
Hewlett-Packard France
Agence Régionale
Centre Vauban
201, rue Colbert
Entrée A2
F-59000 **Lille**
Tel: (20) 51 44 14
Telex: 820744

GERMAN FEDERAL REPUBLIC
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
D-6000 **Frankfurt** 56
Tel: (0611) 50 04-1
Cable: HEWPACKSA Frankfurt
Telex: 04 13249 hpftmd
Hewlett-Packard GmbH
Technisches Buero Boblingen
Herrenbergerstrasse 110
D-7030 **Boblingen**, Württemberg
Tel: (07031) 667-1
Cable: HEPAK Böblingen
Telex: 07265739 bbn
Hewlett-Packard GmbH
Technisches Buero Dusseldorf
Emanuel-Leutze-Str 1 (Seestern)
D-4000 **Dusseldorf**
Tel: (0211) 59 71-1
Telex: 085/86 533 hpdd d
Hewlett-Packard GmbH
Technisches Buero Hamburg
Wendenstrasse 23
D-2000 **Hamburg** 1
Tel: (040) 24 13 93
Cable: HEWPACKSA Hamburg
Telex: 21 63 032 hphh d
Hewlett-Packard GmbH
Technisches Buero Hannover
Am Grossmarkt 6
D-3000 **Hannover** 91
Tel: (0511) 46 60 01
Telex: 092 3259
Hewlett-Packard GmbH
Technisches Buero Nuremberg
Neumeyer Str. 90
D-8500 **Nuremberg**
Tel: (0911) 56 30 83/85
Telex: 0623 860
Hewlett-Packard GmbH
Technisches Buero München
Unterhachinger Strasse 28
ISAR Center
D-8012 **Ottobrunn**
Tel: (089) 601 30 61/7
Cable: HEWPACKSA München
Telex: 0524985
Hewlett-Packard GmbH
Technisches Buero Berlin
Keith Strasse 2-4
D-1000 **Berlin** 30
Tel: (030) 24 90 86
Telex: 18 3405 hpbln d

GREECE
Kostas Karayannis
18, Ermou Street
GR-**Athens** 126
Tel: 3237731
Cable: RAKAR Athens
Telex: 21 59 62 rkar gr
Analytical Only
"INTECO"
G. Papathanassiou & Co
Marni 17
GR - **Athens** 103
Tel: 522 1915
Cable: INTEKNIKA Athens
Telex: 21 5329 INTE GR
Medical Only
Technomed Hellas Ltd.
52,Skoufa Street
GR - **Athens** 135
Tel: 362 6972, 363 3830
Cable:etalak athens
Telex: 21-4693 ETAL GR

HUNGARY
MTA
Müszerügyi és Méréstechnikai
Szolgalata
Lenin Krt. 67
1391 **Budapest** VI
Tel: 42 03 38
Telex: 22 51 14

ICELAND
Medical Only
Elding Trading Company Inc.
Hafnarhvoli - Tryggvatotu
IS-**Reykjavik**
Tel: 1 58 20
Cable: ELDING Reykjavik

IRAN
Hewlett-Packard Iran Ltd.
No. 13, Fourteenth St.
Miremad Avenue
P.O. Box 41/2419
IR-**Tehran**
Tel: 851082-7
Telex: 213405 HEWP IR

IRELAND
Hewlett-Packard Ltd
King Street Lane
GB-**Winnersh**,Wokingham
Berks. RG11 5AR
Tel: (0734) 78 47 74
Telex: 847178

ITALY
Hewlett-Packard Italiana S.p.A.
Casella postale 3645
I-20100 **Milano**
Tel: (2) 6251 (10 lines)
Cable: HEWPACKIT Milano
Telex: 32046
Hewlett-Packard Italiana S.p.A
Via Pietro Maroncelli 40
(ang. Via Visentin)
I-35100 **Padova**
Tel: (49) 66 48 88
Telex: 41612 Hewpacki
Medical only
Hewlett-Packard Italiana S.p.A
Via d'Aghiardi, 7
I-55100 **Pisa**
Tel: (050) 2 32 04
Telex: 32046 via Milano
Hewlett-Packard Italiana S.p.A
Via G. Armellini 10
I-00143 **Roma**
Tel: (06) 54 69 61
Telex: 61514
Cable: HEWPACKIT Roma
Hewlett-Packard Italiana S.p.A
Via San Quintino, 46
I-10121 **Torino**
Tel: (011) 52 82 64/54 84 68
Telex: 32046 via Milano
Medical/Calculators Only
Hewlett-Packard Italiana S.p.A
Via Principe Nicola 43 G/C
I-95126 **Catania**
Tel:(095) 37 05 04
Hewlett-Packard Italiana S.p.A
Via Amerigo Vespucci, 9
I-80142 **Napoli**
Tel: (081) 33 77 11
Hewlett-Packard Italiana S.p.A
Via E. Masi, 9/B
I-40137 **Bologna**
Tel: (051) 30 78 87

KUWAIT
Al-Khaldiya Trading &
Contracting Co
P.O. Box 830
Kuwait
Tel: 42 49 10
Cable: VISCOUNT

LUXEMBURG
Hewlett-Packard Benelux
S.A./N.V.
Avenue du Col-Vert, 1,
(Groenkraaglaan)
B-1170 **Brussels**
Tel: (02) 672 22 40
Cable: PALOBEN Brussels
Telex: 23 494

MOROCCO
Gerep
190, Blvd. Brahim Roudani
Casablanca
Tel: 25-16-76/25-90-99
Cable: Gerep-Casa
Telex: 23739

NETHERLANDS
Hewlett-Packard Benelux N.V.
Van Heuven Goedhartlaan 121
P.O. Box 667
NL- **Amstelveen** 1134
Tel: (020) 47 20 21
Cable: PALOBEN Amsterdam
Telex: 13 216 hepa nl

NORWAY
Hewlett-Packard Norge A/S
Nesveien 13
Box 149
N-1344 **Haslum**
Tel: (02) 53 83 60
Telex: 16621 hpnas n

POLAND
Biuro Informacji Technicznej
Hewlett-Packard
UI Stawki 2 6P
00-950**Warsaw**
Tel: 39 67 43
Telex: 81 24 53 hepa pl

UNIPAN
Zaklad Doswiadczalny
Budowy Aparatury Naukowej
UI. Krajowej Rady
Narodowej 51/55
00-800 **Warsaw**
Tel: 20 62 21
Telex: 81 46 48
Zaklady Naprawcze Sprzetu
Medycznego
Plac Komuny Paryskiej 6
90-007 **Lodz**
Tel: 334-41, 337-83

PORTUGAL
Telectra-Empresa Técnica de
Equipamentos Eléctricos S.a.r.l.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
P-**Lisbon** 1
Tel: (19) 68 60 72
Cable: TELECTRA Lisbon
Telex: 12598
Medical only
Mundinter
Intercambio Mundial de Comércio
S.a.r.l.
Av.A.A.de Aguiar 138
P.O. Box 2761
P - **Lisbon**
Tel: (19) 53 21 31/7
Cable: INTERCAMBIO Lisbon

RUMANIA
Hewlett-Packard Reprezentanta
BD.N. Balcescu 16
Bucharest
Tel: 158023/138885
Telex: 10440
I.I.R.U.C.
Intreprinderea Pentru
Intretinerea
Si Repararea Utilajelor de Calcul
B-dul prof. Dimitrie Pompei 6
Bucharest-Sectorul 2
Tel: 12 64 30
Telex: 01183716

SAUDI ARABIA
Modern Electronic Establishment
King Abdul Aziz str. (Head office)
P.O. Box 1228
Jeddah
Tel: 31173-332201
Cable: ELECTRA
P.O. Box 2728 (Service center)
Riyadh
Tel: 62596-66232
Cable: RAOUFCO

SPAIN
Hewlett-Packard Española, S.A.
Jerez No. 3
E-**Madrid** 16
Tel:(1) 458 26 00 (10 lines)
Telex: 23515 hpe
Hewlett-Packard Española, S.A.
Milanesado 21-23
E-**Barcelona** 17
Tel. (3) 203 6200 (5 lines)
Telex: 52603 hpbe e
Hewlett-Packard Española, S.A.
Av Ramón y Cajal, 1-9°
(Edificio Sevilla I)
E-**Seville** 5
Tel: 64 44 54/58
Hewlett-Packard Española S.A.
Edificio Albia II 7° B
E-**Bilbao** 1
Tel: 23 83 06/23 82 06
Calculators Only
Hewlett-Packard Española S.A.
Gran Via Fernando El Catdlico, 67
E-**Valencia**-8
Tel: 326 67 28/326 85 55

SWEDEN
Hewlett-Packard Sverige AB
Enighetsvägen 3
Fack
S-161 20 **Bromma** 20
Tel: (08) 730 05 50
Cable: MEASUREMENTS
Stockholm
Telex: 10721
Hewlett-Packard Sverige AB
Frötallsgatan 30
S-421 32 **Västra Frolunda**
Tel: (031) 49 09 50
Telex: 10721 Via Bromma Office

SWITZERLAND
Hewlett-Packard (Schweiz) AG
Zurcherstrasse 20
P.O. Box 307
CH-8952 **Schlieren-Zurich**
Tel: (01) 730 52 40
Cable: HPAG CH
Telex: 53933 hpag ch
Hewlett-Packard (Schweiz) AG
Château Bloc 19
CH-1219 **Le Lignon-Geneva**
Tel: (022) 96 03 22
Cable: HEWPACKAG Geneva
Telex: 27 333 hpag ch

SYRIA
Medical Calculator only
Sawan & Co
Place Azmé
B.P. 2308
SYR-**Damascus**
Tel: 16367, 19697, 14268
Cable: SAWAH, Damascus

TURKEY
Telekom Engineering Bureau
P.O. Box 437
Beyoglu
TR-**Istanbul**
Tel: 49 40 40
Cable: TELEMATION Istanbul
Telex: 23609
Medical only
E.M.A.
Muhendislik Kollektif Sirketi
Adakale Sokak 41/6
TR-**Ankara**
Tel: 175622
Analytical only
Yilmaz Ozyurek
Milli Mudafaa Cad No. 16/6
Kizilay
TR-**Ankara**
Tel: 25 03 09
Telex: 42576 Ozek tr

UNITED KINGDOM
Hewlett-Packard Ltd
King Street Lane
GB-**Winnersh**, Wokingham
Berks. RG11 5AR
Tel: (0734) 78 47 74
Cable: Hewpie London
Telex:847178/9
Hewlett-Packard Ltd.
"The Graftons"
Stamford New Road
GB-**Altrincham**
Cheshire WA14 1DO
Tel: (061) 9289021
Cable: Hewpie Manchester
Telex: 668068
Hewlett-Packard Ltd
Lygon Court
Dudley Road
GB-**Halesowen**, Worcs
Tel: (021) 550 9911
Telex: 339105
Hewlett-Packard Ltd
Wedge House
799, London Road
GB-**Thornton Heath**
Surrey CR4 6XL
Tel: (01) 6640103
Telex: 946825
Hewlett-Packard Ltd
c/o Makro
South Service Wholesale Centre
Wear Industrial Estate
Washington
GB-**New Town**, County Durham
Tel: Washington 464001 ext. 57/58
Hewlett-Packard Ltd
10, Wesley St
GB-**Castleford**
West Yorkshire WF10 1AE
Tel: (09775) 50402
Telex: 557355
Hewlett-Packard Ltd
1, Wallace Way
GB-**Hitchin**
Herts
Tel: (0462) 52824/56704
Telex: 825981

USSR
Hewlett-Packard
Representative Office USSR
Pokrovsky Boulevard 4/17-KV 12
Moscow 101000
Tel:294-2024
Telex: 7825 hewpak su

YUGOSLAVIA
Iskra-standard/Hewlett-Packard
Miklosiceva 38/VII
61000 **Ljubljana**
Tel. 31 58 79/32 16 74
Telex: 31300

SOCIALIST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard Ges.m.b.H.
P.O. Box 7
A-1205 **Vienna**, Austria
Tel: (0222) 35 16 21 to 27
Cable: HEWPAK Vienna
Telex: 75923 hewpak a

MEDITERRANEAN AND MIDDLE EAST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard S.A.
Mediterranean and Middle
East Operations
35, Kolokotroni Street
Platia Kefallariou
GR-Kifissia-**Athens**, Greece
Tel: 8080337/359/429
8081741/742/743/744
Telex: 21-6588
Cable: HEWPACKSA Athens

FOR OTHER AREAS NOT LISTED CONTACT
Hewlett-Packard S.A.
7, rue du Bois-du-Lan
P.O. Box
CH-1217 Meyrin 2 - **Geneva**
Switzerland
Tel. (022) 41 54 00

UNITED STATES

ALABAMA
2230 Whitesburg Dr., S.E.
P.O. Box 4207
Huntsville 35802
Tel: (205) 881-4591
Medical Only
228 W. Valley Ave.,
Room 220
Birmingham 35209
Tel: (205) 942-2081

ARIZONA
2336 E. Magnolia St.
Phoenix 85034
Tel: (602) 244-1361
2424 East Aragon Rd.
Tucson 85706
Tel: (602) 294-3148

***ARKANSAS**
Medical Service Only
P.O. Box 5646
Brady Station
Little Rock 72205
Tel:)501) 664-8773

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000
3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170
6305 Arizona Place
Los Angeles 90045
Tel: (213) 649-2511
TWX: 910-328-6147
***Los Angeles**
Tel: (213) 776-7500
3003 Scott Boulevard
Santa Clara 95050
Tel: (408) 249-7000
TWX: 910-338-0518
***Ridgecrest**
Tel: (714) 446-6165
646 W. North Market Blvd
Sacramento 95834
Tel: (916) 929-7222
9606 Aero Drive
P.O. Box 23333
San Diego 92123
Tel: (714) 279-3200

COLORADO
5600 South Ulster Parkway
Englewood 80110
Tel: (303) 771-3455

CONNECTICUT
12 Lunar Drive
New Haven 06525
Tel: (203) 389-6551
TWX: 710-465-2029

FLORIDA
P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
Tel: (305) 731-2020
***Jacksonville**
Medical Service only
Tel: (904) 725-6333
P.O. Box 13910
6177 Lake Ellenor Dr.
Orlando 32809
Tel: (305) 859-2900
P.O. Box 12826
Pensacola 32575
Tel: (904) 434-3081

GEORGIA
P.O. Box 105005
Atlanta 30348
Tel: (404) 955-1500
TWX 810-766-4890
Medical Service Only
***Augusta** 30903
Tel: (404) 736-0592

HAWAII
2875 So. King Street
Honolulu 96814
Tel: (808) 955-4455

ILLINOIS
5201 Tollview Dr.
Rolling Meadows 60008
Tel: (312) 255-9800
TWX: 910-687-2260

INDIANA
7301 North Shadeland Ave.
Indianapolis46250
Tel: (317)842-1000
TWX: 810-260-1797

IOWA
1902 Broadway
Iowa City 52240
Tel: (319) 338-9466
Night: (319) 338-9467

KENTUCKY
Medical Only
Atkinson Square
3901 Atkinson Dr.,
Suite 207
Louisville 40218
Tel: (502) 456-1573

LOUISIANA
P.O. Box 840
3239 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-9157
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
23855 Research Drive
Farmington Hills 48024
Tel: (313) 476-6400
TWX: 810-242-2900

MINNESOTA
2400 N. Prior Ave.
Roseville 55113
Tel: (612) 636-0700
TWX: 910-563-3734

MISSISSIPPI
***Jackson**
Medical Service only
Tel: (601) 982-9363

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087
148 Weldon Parkway
Maryland Heights 63043
Tel: (314) 567-1455
TWX: 910-764-0830

NEBRASKA
Medical Only
7171 Mercy Road
Suite 110
Omaha 68106
Tel: (402) 392-0948

NEW JERSEY
W. 120 Century Rd.
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

NEW MEXICO
P.O. Box 11634
Station E
11300 Lomas Blvd., N.E.
Albuquerque 87123
Tel: (505) 292-1330
TWX: 910-989-1185
156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
6 Automation Lane
Computer Park
Albany 12205
Tel: (518) 458-1550
201 South Avenue
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012
39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981
5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
1 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300
TWX: 710-990-4951

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101

OHIO
16500 Sprague Road
Cleveland 44130
Tel: (216) 243-7300
TWX: 810-423-9431
330 Progress Rd.
Dayton 45449
Tel: (513) 859-8202
TWX: 810-474-2818
1041 Kingsmill Parkway
Columbus 43229
Tel: (614) 436-1041

OKLAHOMA
P.O. Box 32008
Oklahoma City 73132
Tel: (405) 721-0200

OREGON
17890 SW Lower Boones
Ferry Road
Tualatin 97062
Tel: (503) 620-3350

PENNSYLVANIA
111 Zeta Drive
Pittsburgh 15238
Tel: (412) 782-0400
TWX: 710-795-3124
1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

SOUTH CAROLINA
6941-0 N. Trenholm Road
Columbia 29260
Tel: (803) 782-6493

TENNESSEE
***Knoxville**
Medical Services only
Tel: (615) 523-5022
1473 Madison Avenue
Memphis 38104
Tel: (901) 274-7472
Nashville
Medical Service only
Tel: (615) 244-5448

TEXAS
P.O. Box 1270
201 E. Arapaho Rd.
Richardson 75080
tel: (214) 231-6101
P.O. Box 27409
6300 Westpark Drive
Suite 100
Houston 77027
Tel: (713) 781-6000
205 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-8241

UTAH
2160 South 3270 West Street
Salt Lake City 84119
Tel: (801) 487-0715

VIRGINIA
Medical Only
P.O. Box 12778
No. 7 Koger Exec. Center
Suite 212
Norfolk 23502
Tel:(804) 497-1026/7
P.O.Box 9854
2914 Hungary Springs Road
Richmond 23228
Tel: (804) 285-3431

WASHINGTON
Bellefield Office Pk.
1203-114th Ave. S.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2446

***WEST VIRGINIA**
Medical/Analytical Only
Charleston
Tel: (304) 345-1640

WISCONSIN
9004 West Lincoln Ave
West Allis 53227
Tel: (414) 541-0550

FOR U.S. AREAS NOT LISTED:
Contact the regional office
nearest you: Atlanta, Georgia.
North Hollywood, California.
Rockville, Maryland. Rolling Meadows,
Illinois. Their complete
addresses are listed above.

***Service Only**